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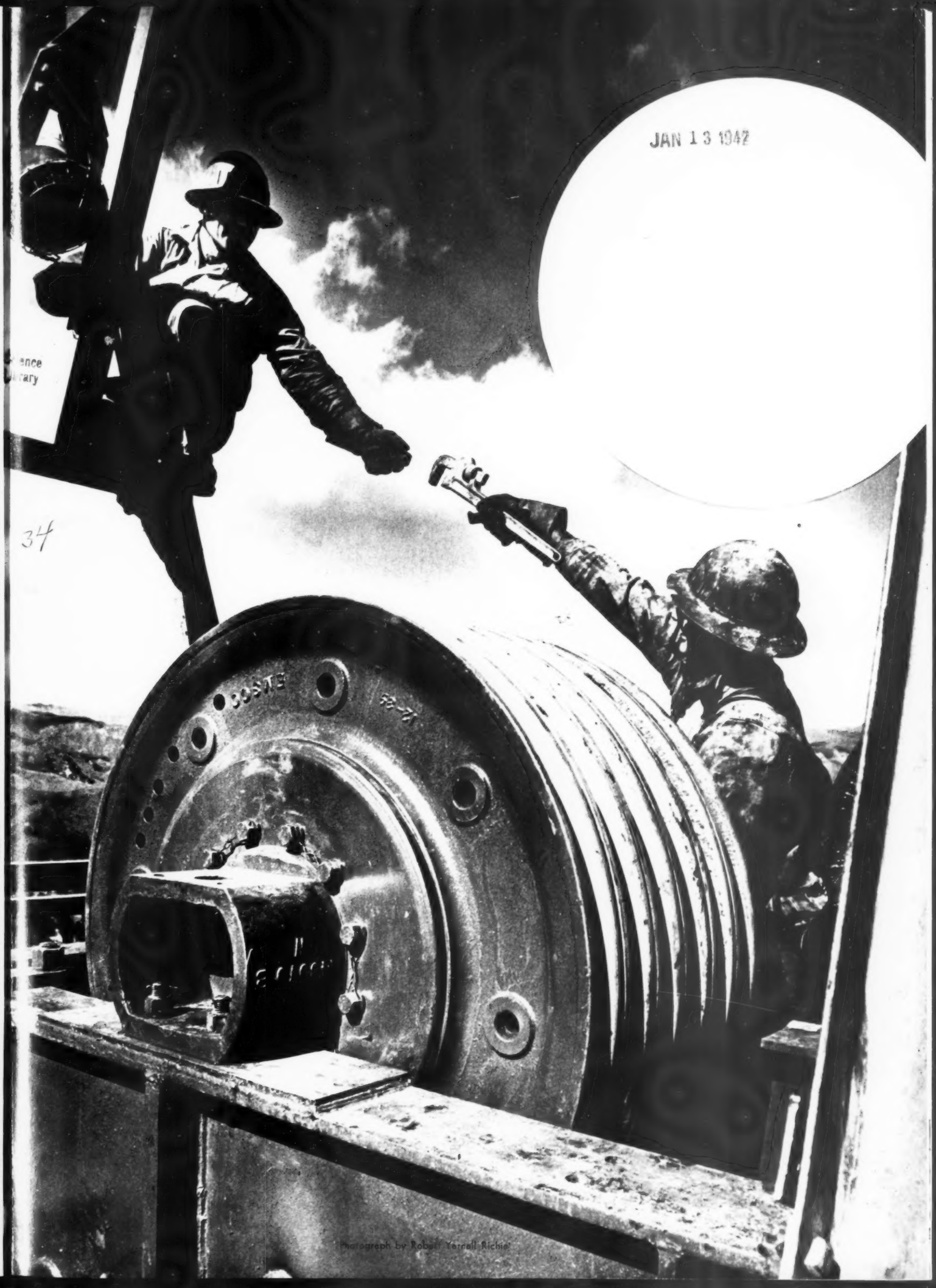

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Incorporating Petroleum Equipment Exporter

THE MANAGEMENT PUBLICATION OF THE INTERNATIONAL PETROLEUM INDUSTRY

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Detail of a California refinery by Cy La Tour

OIL NOW A DECISIVE FACTOR

Japan's resort to war against the United States and Britain has made the present struggle a world conflict in the fullest sense of the term. There now is no quarter of the globe not involved in hostilities. Japan's action, with its prompt affirmation by Nazi Germany and Facist Italy, has had the further effect of establishing oil as a wholly decisive factor in this clash of irreconcilable forces arrayed against each other.

There is a twofold basis for this situation. Every extension of the arena of conflict from the beginning has made it more and more evident that this is a war of machines —of planes and ships and tanks. All of these mobile weapons depend upon liquid fuel for their effectiveness, indeed for their slightest movement. Men must operate these instruments of defense and destruction but the machines are helpless and their operators impotent without the specialized fuels that give them power. The only limitation upon their capacity for attack or resistance is the availability of fuel supplies. Every nation participating in this world wide battle can produce or obtain guns, planes and motorized equipment in large or smaller numbers but not all can continue to find oil in sufficient quantity to supply these fighting instruments and keep them in full and effective operation.

This is the second and all-important factor in weighing the balance between the two contending groups. In the early period of the war the Nazis were able to replenish their inadequate domestic supplies from several directions; from Russia, through the Baltic and via Italy through the Mediterranean. By their conquest of neighboring countries they were able to get full control of Rumania's oil fields and to seize substantial stocks in the areas they invaded. Until a short time before the Japanese began their open assault on the Axis opponents they were able to import oil freely and in large quantities; from the United States, Netherlands India and other producing areas. Thereby they accumulated very large reserves in store, how large nobody outside Japan's inner military circle knows exactly, but sufficient undoubtedly to sustain a strong offensive effort for many months, probably a year, perhaps still longer.

Now the doors are closed. Not one of the Axis powers is capable of providing from its own territory or from the areas that it has overrun thus far sufficient oil to meet the needs of a continuing large scale campaign. All the great oil fields of the world—the Caucasus, the Near East, the Far East and the incomparable resources of North and South America—are in the hands of the nations arrayed against Totalitarianism. They must be held at all costs. If they are held the fighting power of the Axis group will presently wane. Outgo in excess of replacement cannot continue indefinitely. Accumulated reserves, no matter how great, will be eaten up. A vigorous attack from all quarters, with no respite such as Germany has enjoyed until recently permitting the accumulation of fresh stocks, will take its unerring toll and lead to certain triumph for those who possess and use to full advantage the invincible weapon of superiority in oil and in facilities for using it.

This very situation imposes a tremendous responsibility upon those who now control this vital arm of victory. For the military leaders the primary requirement is to make certain first of all that the totalitarian powers gain control of none of these strategic oil fields. Their vital importance is fully recognized by the leaders of the Axis group and to gain possession of some part of these invaluable resources they will take desperate risks. Secondly, from the viewpoint of strategic operation, is the necessity of attacking and destroying the petroleum stocks and facilities of production of the enemy, his refineries, stores and transport equipment, to bring nearer the time when shortage of indispensable fuel supplies shall sap his capacity for resistance.

No less a responsibility rests upon the oil industry itself. Theirs is the task of providing an ample and unfailing supply of all those products necessary to the operation of planes and ships, tanks and trucks, for the lubrication of this fighting equipment and of the great industrial machine that produces it and all its accessories. Because the United States produces and processes oil in greater volume than all the rest of the world the crux of this burden must fall upon the oil men of America. No

longer is it a question of raising the output of one or another product to some predetermined figure. All-out war calls for an all-out effort, not merely to satisfy the needs of the country's own armed forces, but to help meet the requirements of all other nations that are battling the common foe. For this task the oil industry is now mobilized. To its accomplishment the members of the industry have dedicated themselves for so long a time as may be necessary to bring complete victory.

INTERNATIONAL PETROLEUM COUNCIL NEEDED

Since the nations now warring against the Axis powers have been the successive objects of aggression and have been drawn into the conflict singly and at different times instead of as a group they have had no concerted strategy or singleness of direction such as has existed among their opponents. There the supervision exercised by Nazi leaders has been clearly evident in every step taken, not merely by such humble henchmen as the Italians, Hungarians and Rumanians, but even in the tactics and strategy of those noble "yellow Aryans", the Japanese. To prosecute the war effectively a directing force to establish unity of action, a supreme council to provide for joint operations, supporting movements and the allocation of munitions and supplies in the most effective manner was recognized as a necessity as soon as this battle zone was extended to the Pacific. Steps to establish such strategic military direction were taken immediately and the plan should be in operation by the time these lines appear in print.

In the matter of petroleum, which obviously must play a most important part in overcoming the Totalitarian drive, there is equal reason for setting up an international committee for the purpose of determining requirements and seeing that supplies of products needed by the fighting forces are put in their hands with the greatest possible economy in time and transport facilities. The war is being fought on many fronts and the task of keeping them supplied with the special products they require, of obtaining these from the most accessible source and of providing transport where and when it is needed calls for comprehensive information and broad organization. If one source of supply is shut off another must be brought into use without delay. Certain grades of crude especially adapted to the manufacture of specific products are found only in a few limited areas. America, for example, must provide high quality lubricants for the allied fighting areas in all parts of the world. There are many details to be worked out, particularly in the allocation of aviation super fuel to the various segments of a world wide front.

Whether the titular heads of the joint petroleum council be civilians or military officers, the organization and administration of its work should be in the hands of men who have had practical experience in the international oil industry. Their knowledge of the character and productive possibilities of the world's oil fields and refineries, of trade routes, storage facilities and transportation equipment, will enable them to handle the joint task in the same manner and with the same efficiency as they have conducted their regular duties in the past.

Such a joint body need not interfere with the efforts of the oil industry in different producing areas to attain the maximum of efficiency in its own operations but it could do much to eliminate waste effort and duplication in distribution and could make sure that essential supplies of 100-octane gasoline, fuel and lubricating oils were made steadily available in places and quantities as most needed. It could see to it in short that these important wartime materials were employed to the best possible advantage toward the attainment of ultimate success on all fronts and in every phase of the conflict.

DEFENSE SERVICE OPEN TO ALL

Least painful and most effective among the plans devised for bringing about nation-wide participation in financial support of America's war effort is the defense savings payroll allotment plan which is described in detail on page 66 of this issue. The plan has the merit of extreme simplicity in operation and of adaptability to incomes of all sizes. It involves a minimum of record keeping and can be established with equal facility in the smallest or largest establishments.

For the employer the only action required is an expression of willingness to make the plan available to his employees and to install and maintain the card index file needed to record payments as they are made. Section A of the Treasury Department in Washington will supply sample materials and an explanation of the method to be employed on receipt of the inquiry coupon provided. If further advice and instructions are needed representatives of local committees which have been established in most localities will supply it without cost.

The employee's part consists in authorization that a small sum be withheld from his or her envelope each pay day and applied toward payment for a defense savings bond. The amount to be so treated is determined by each individual according to his ability and desire to contribute toward the purchase of planes, tanks and guns with which to fight the nation's battles. Participation is entirely voluntary. Suggestions of a compulsory payroll deduction have been made in Washington but if the great majority of workers in America's shops, factories and offices join in enlisting a few of their dollars, such action will be unnecessary. After all it is our war now and the American way of licking a job of this kind is for each to do his part willingly and promptly.

Japanese refinery at Kawasaki: from left to right may be seen combination topping and cracking unit, absorption and stabilizer and lubricating units.

JAPANESE STRATEGY

Based on Inadequate Oil Supply

By Walter Levy

Japan, Like Germany, Lacked Adequate Domestic Sources of Petroleum But Adopted a Policy of Storage, Synthesis, Refining and a Fleet of Fast Tankers in the Hope of Obtaining Supplies Before Storage is Exhausted. Policy and Actual Situation is Herewith Analysed.

THE THREE Axis countries with whom the United States is now at war have for many years concentrated their energies to prepare themselves for this life and death struggle. One of the most difficult economic problems of their war planning has been the task of assuring sufficient quantities of oil in wartime. There is no doubt that the utmost attention has been paid to this program and that a common plan was formulated many years ago; as a matter of fact probably in 1934-35. It is perhaps worth mentioning that in the latter year a very high official of the Navy Department of the German War Ministry was sent to Japan to study the country's oil position in wartime, to advise the Nipponese Government on the Nazi plan for the solution of these problems and to prepare a report for the German Economic General Staff. His conclusions were published in 1936 and may be summarized as follows:

Japanese annual oil demand in wartime for civil and military purposes may be estimated (calculated in the form of crude oil) at 105,000,000 bbl. Of this quantity 56,000,000 bbl. would be required to produce gas oil and fuel oil for the Navy, assuming a tonnage of 1,100,000—a figure which corresponds to the latest available estimate. An air fleet of 3,000 airplanes would require 8,000,000 to 9,000,000 bbl. of aviation gasoline, which would be produced from 21,000,000 bbl. of crude oil. The remaining 28,000,000 bbl. of crude would be used to supply the Army and to meet domestic demand. The report expressed not the slightest doubt that even with the most energetic efforts it would be impossible for Japan to produce this quantity of oil from domestic resources. A considerable balance would have to be covered by importation. As imports might be cut off and as any war in which Japan would fight against the United States would be a long and costly war against an enemy possessing oil and oil-driven implements of war in abundance, Japan could not dare to depend on stocks alone. She would have to conquer first and foremost new sources of natural oil supplies. And here, according to the German expert, Japan is in a somewhat more favorable position than the Reich. The coastal and island territories in the Pacific contain most valuable oil fields, while the territories on the borders of the Atlantic Ocean in Europe lack natural petroleum resources.

These conclusions hold good even for today when the exaggerated estimates of oil requirements in wartime have been reduced after the actual experience of two years of war in Europe. To show the problem of achieving self-sufficiency in its true perspective a few data on Japanese oil requirements in the last few years will be given. Consumption, excluding Navy imports and the quantities which merchant ships bunkered abroad, amounted to about 24,000,000 bbl. in 1936. Only some 10 to 15 percent of this quantity was produced at home. The outbreak of the war with China led to a large increase in demand despite stringent economy in civilian consumption. Domestic requirements in Japan have always been relatively small. The country possesses only 210,000 motor vehicles as against 32 million units in the United States. Industrial requirements for heavy oils are also relatively uninportant, as the country, in view of its oil shortage, used coal instead of Diesel and fuel oil wherever possible. Principal consumer of motor fuel is the commercial road transport industry; heavy oils are used for the Navy and merchant marine. Lubricants are of course indispensable for industry and transport. In spite of all efforts to restrict consumption by the introduction of gasoline rationing in May 1938,

the increase of motor fuel taxation to an excessive level, prohibiting the use of oil for heating and cooking purposes, and the compulsory use of substitutes, the field for possible savings without harming the country's war effort was very small indeed. On the contrary the extraordinary expansion in heavy industries, the development of vast territories in Manchuria and China which were largely dependent on road transport, led to an expansion of demand which, according to Japanese sources, has been appreciable. If we add to that the military and naval requirements for the war in China which must also have been heavy, a consumption of between 35,000,000 and 40,000,000 bbl. in 1940—a figure frequently mentioned in American literature — seems certainly not exaggerated. The war with America will add considerably to requirements as long as the Japanese Navy, air force, and land army are operating over vast territories. At the same time the whole Yenbloc area including Thailand and Indo-China is cut off from its imported supplies and has to fall back on its domestic production, stocks and imports from Japan. The crucial question is thus: how much is Japan able to produce at home, how big are her stocks, and how long will they be able to cover deficiencies, and finally, what strategy will Japan have to follow if she attempts to solve her wartime oil problem?

A review of Japan's oil policy immediately reveals striking similarities to the German pattern of war preparations with the one important difference that Germany did not count on overseas imports from neutral or conquered territories, while Japan definitely did. The practical consequence is that Germany did not strive to build up a big refining industry which would be able to treat crude oil from abroad nor did the Reich concentrate on the creation of a large and fast-moving tanker fleet. Japan, on the other hand, took all kinds of measures to establish a modern and efficient refining industry and to acquire a relatively large tanker fleet. As a matter of fact, Japan was one of the first countries to build tankers with the speed of 19 knots and over. The need for these vessels arose not only from the necessity to import oil from abroad but also from the problem of refueling the Navy outside home waters. In contrast to Germany the intention of the Japanese Naval Staff was obviously not to keep the fleet safely tucked away under the protection of Japanese ports.

The measures to increase the production of natural and synthetic oil in the country show a close resemblance to the German autarchy plan. Conditions for oil self-sufficiency were indeed somewhat similar. Domestic resources of natural crude oil in both countries are very limited while sufficient coal deposits are available for the creation of a large synthetic coal oil industry. A plan was formulated long before the whole economy of Japan could be put on a war footing by the National Mobilization Law of March 1938. Petroleum was one of the first raw materials for which a comprehensive war economy was introduced. The government set out systematically: (1) to control production, imports, refining, distribution and storage; (2) to encourage refining; (3) to intensify exploration and exploitation of natural resources; (4) to promote a synthetic oil industry; (5) to increase the use of substitutes; (6) to build up huge stocks; (7) to expand the tanker fleet; (8) to achieve a better utilization of available resources and a greater economy in consumption. The legal and economic instruments with which the government carried through its plans were first of all the Petroleum Industry Law of 1934. This law subjected production, imports, refining, and distribution to government control, entitled the government to fix maximum prices, and to prescribe quotas for imports and refining. Trade and industry had moreover to carry at all times a minimum of six months' stock. Foreign companies operating in Japan first refused to comply with the storage provision law, but in 1936 they came to an agreement with the government. Mitsubishi interests erected the necessary storage tanks for the foreign companies and leased the tanks to them, while the government promised to compensate them for any losses sustained through carrying out of the storage obligations. At the same time the Japanese tariff policy favored the importation of crude and heavy oil for further refining. Imports of finished products declined successively and the newly created Japanese refining industry supplied an ever-growing proportion of the market.

In June 1937 the government established a Fuel Bureau under the Ministry of Commerce and Industry to carry out the national fuel policy to encourage exploitation of all natural resources, to administer the petroleum industry laws, to help in the creation of a synthetic oil industry and to promote a better utilization of oil products. In accordance with that plan the government created an alcohol monopoly and introduced the compulsory alcohol admixture bill. The production of alcohol became, as in Germany, a government monopoly. The rate of admixture was increased from five percent at that time to 20 percent in 1941. At the same session of the Diet the Synthetic Petroleum Production Law and the Imperial Fuel Development Company Law were passed (July-August, 1937) and the Petroleum Resources Exploitation Law came into effect in March 1938. Licenses were issued for the erection of synthetic oil plants, subsidies were promised and exemptions from duty were granted for the imports of material for the next seven years. Plants were also free from local taxation. To safeguard the national character of the industry more than 50 percent of the capital had to remain in Japanese hands. In January 1938 the Imperial Fuel Industrial Co. was founded with a capital of 100,000,000 Yen ($23,500,000 at pre-war exchange rates), half of which was contributed by the government, and the right to issue debentures for another 300,000,000 Yen ($70,500,000). The chief object of this company was to provide capital for the synthetic oil industry. The government hoped with all these measures to carry through its Seven Year Plan which in 1936 had been formulated for Japan and Manchuria. It was planned to produce by 1943 17,650,000 bbl. of oil from domestic sources to meet at least half of the total demand. The plan in detail is indicated in an accompanying table. The capital necessary for this program was estimated at 770,000,000 Yen ($180,950,000), half of which would be provided by the Imperial Fuel Development Co. About 340,000,000 Yen ($79,900,000) were to be invested in hydrogenation, 150,000,000 Yen ($35,250,000) in synthetic processes, 120,000,000 Yen ($28,200,000) in low temperature distillation, and 130,000,000 Yen ($30,550,000) in the exploitation of coal mines. For the production of the 13,600,000 bbl. of coal oil it was estimated that 8,900,000 tons of coal would be needed for the processing and another 1,000,000 tons for the production of hydrogen. First experiments in the erection of coal oil plants were actually commenced in 1936 and three methods were to be used. First direct liquefaction, developed by the Navy Fuel Depot together with the South Manchuria Railway Co. and the Chosen Nitrogen Fertilizer Co., or hydrogenation. It was hoped that these processes would yield gasoline with an octane rating of 70 to 80. Second, the Fischer-Tropsch process acquired by the Mitsui Mining Co., and third, low temperature distillation. The original program was frequently changed. First of all the plan was reduced from seven to five years so as to be ready for 1941. At the same time an increase by as much as 85 percent was decreed. This, however, proved impracticable, for according to all available information it was impossible even to fulfill the original plan figures.

Shortly after the announcement of the Seven Year Plan war with China broke out, seriously deranging the schedule. The ambitious self-sufficiency program had, for some time at least, to be curtailed. It became increasingly difficult to follow the course of Japanese supplies and requirements. All information which might clarify the state of affairs in this important field was carefully suppressed by the authorities. Publication of detailed trade statistics for oil imports was stopped at the outbreak of hostilities, and no official figures on the success of the self-sufficiency program were any longer available. It is only known that as the war in China dragged on year after year, domestic consumption in Japan had to be severely and progressively restricted. Efforts were continued to enlarge crude oil production, to build new coal oil plants

JAPANESE SEVEN YEAR PLAN

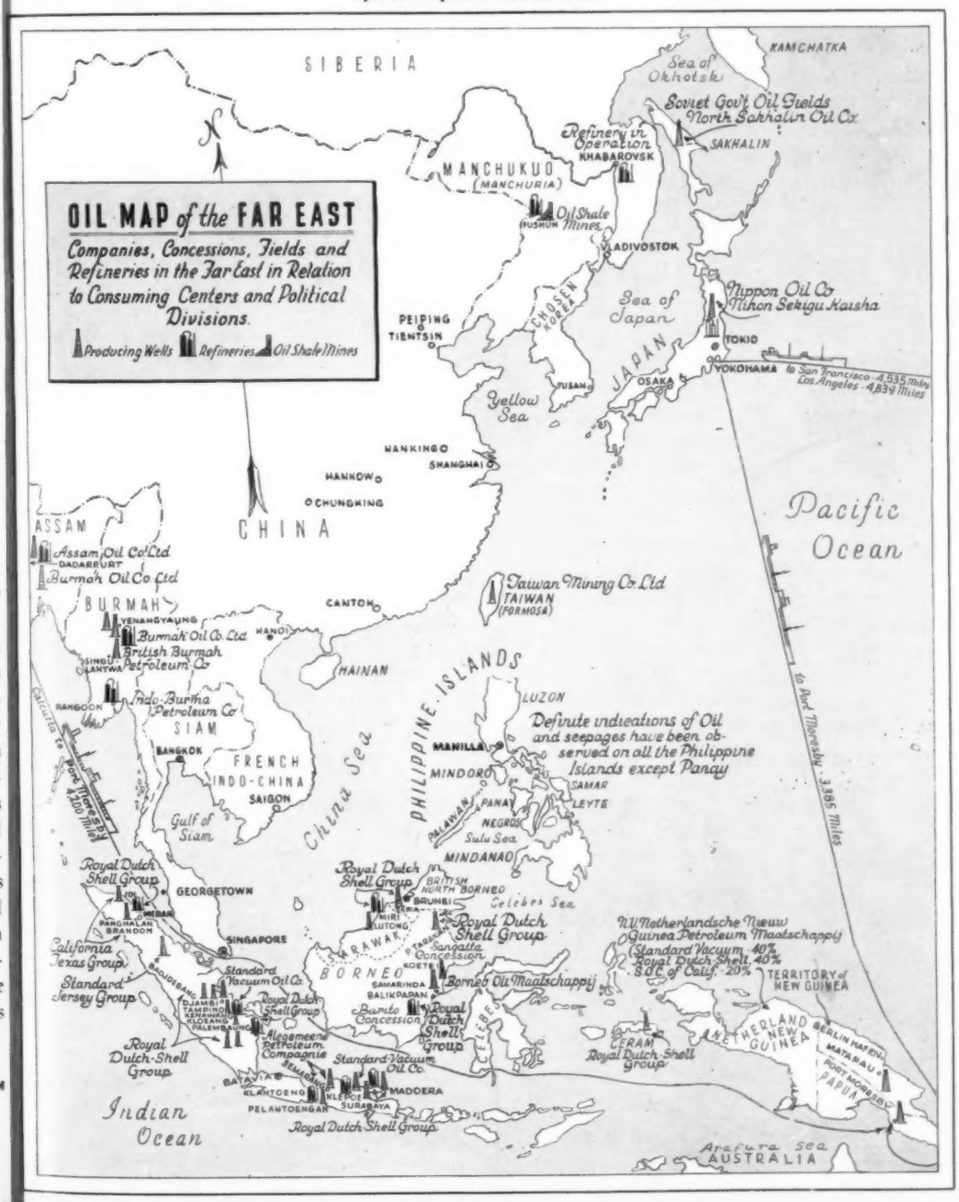
(Thousand Barrels)

	Motor Fuel		Heavy Oils	
	1936	1943	1936	1943
Domestic Production				
From domestic crude oil ..	478	585	761	925
Synthetic oil	13	6,466	220	7,164
Alcohol	...	2,510	...	...
TOTAL Domestic Production	491	9,561	981	8,089
Imports required	8,000	5,975	9,083	9,901
Total domestic demand	8,491	15,536	10,064	17,990
Domestic Production in percent of demand	5.8	61.6	9.8	44.8

and to manufacture various substitute fuels. But by 1939 progress was still very slow indeed. The government itself stated that Japan's crude oil deposits were not entirely insignificant, that delays were experienced in the construction of the hydrogenation works, and that the first Fischer plant for the production of synthetic oil would start operations in the summer of 1939, while further plants were scheduled to start production in the early part of 1941. At the same time a new three-year plan was announced, according to which, by 1942, the production of gasoline from domestic crude oil was to be advanced by 30 percent and that of heavy oil by 40 percent. Synthetic motor fuel production was to be increased by 2,900 percent, synthetic heavy oils by 800 percent, and motor alcohol by 1,200 percent. But again, shortage of foreign currency and delays in the delivery of the necessary equipment from Germany, which was already involved in war against the western democracies, hindered progress. Another factor of primary importance was the difficulty of increasing coal production sufficiently, due to labor scarcity, lack of mining equipment, and transport problems. Alcohol production was hampered by irregular supplies of molasses and potatoes.

The latest information from Japanese sources on the actual progress of the coal oil industry, on location of plants, capacity and process used, dates from 1939-40. By 1939 most of the companies had not yet reached the stage of industrial production, though a gradual progress was recognizable. The finance for the ambitious plan was mainly provided by the Imperial Fuel Development Co., the various Mitsui, Mitsubishi, and Noguchi interests and the Manchurian Government. According to these data there were to be some 22 plants in operation or under construction in 1940-41, with an estimated planned capacity of some 7,000,000-9,000,000 bbl. per annum. In the meantime it may be expected that new projects have been formulated. In some cases efforts probably have been made to increase the initial capacity of the plants. The Japanese laid out the whole synthetic oil program very carefully and spent many years in planning and experimenting, so that when the initial stage was over they would be able to erect a large industry within a comparatively short time. In many cases, however, probably for a majority of the plants, actual performance will have fallen far short of the program. The ever-growing scarcity of labor and materials and the economic upheaval caused by the European war and especially difficulties in obtaining supplies from Germany must have most seriously affected Japan's coal oil industry.

Synthetic plants not shown.



Great importance was also attached to shale oil production from the large fields in Manchuria. Reserves there are estimated at 5,000,000,000 tons with an average content of six percent of shale oil. It was first intended to increase producing capacity from 500,000 bbl. in 1935 to 2,500,000 bbl. by 1938. In March, 1939, the South Manchurian Railway Co. decided to increase production to 3,500,000 bbl. by 1941 and to 7,000,000 bbl. by 1943 at an expenditure of 150,000,000 Yen ($35,250,000). It was considered to be more advantageous to produce oil from shale rather than from coal as the method had been tested, valuable coal was conserved and expenses were much lower. As a matter of fact there are many indications that the coal oil industry in Manchuria had to cope with many unexpected difficulties and the discrepancy between plan and accomplishment in this division was exceptionally large. As far as domestic crude oil production was concerned, not much hope was placed on a large expansion of output. To intensify exploitation measures similar to those adopted in Germany were taken. The Petroleum Resources Exploitation Law formulated a five-year plan for an intensive search for crude oil. The government exercised supervision and control of drilling operations and could compel owners of concessions to cooperate among themselves. Subsidies for the drilling of new wells amounting to many millions of Yen were to be advanced in the form of loans repayable if and when the prospector struck oil.

Efforts to obtain control of foreign oil sources were made by systematic attempts to gain concessions in oil producing countries like Netherlands India, British Borneo, Mexico, Ecuador and even Roumania. A special company, the Pacific Petroleum Co., was formed in 1939 to acquire concession areas. The only important acquisition was the concession obtained in the Russian part of the Island of Sakhalin in 1925. There were many difficulties with the Soviets over the concession but it seems safe to say that without fighting it will be impossible to dislodge the Japanese from this area which supplies the Navy with part of its requirements. Production is in the hands of the North Sakhalin Petroleum Co., which received subsidies from the government. Formerly the Russians sold part of their Sakhalin output to the Japanese but these sales were stopped when the Soviet refinery at Khabarovsk on the Amur River was completed. Japan hoped to produce as much as 3,500,000 bbl. of oil by 1941 in Sakhalin, but actual output is just over half this figure. Though the reserves of this area would probably be sufficient to provide larger quantities of oil for Japan, transport of oil from Sakhalin constitutes a difficult problem; for nine months in the year shipping is hampered or prevented by ice so that huge storage installations for the production during

this period have to be built and the whole output has to be shipped in the three or four ice-free months of the year.

The role of substitutes in Japanese oil economy has only lately become significant. The reasons are not only technical inferiority and higher costs compared with gasoline, but also difficulties in providing large quantities of substitute material. They can moreover not be used for military purposes because they would immediately give an initial advantage to the enemy who has abundant supplies of oil for his war machines. Their use is thus restricted to civilian purposes. Substitutes now in use are: (1) gas, generated from charcoal, firewood, coalite, acetylene, and (2) natural gas, petroleum gas, and methane gas from garbage, etc. Coalite, a semi-finished coke, is in great demand for the iron production so that supplies for motor car use are very small. Acetylene is also scarcely available as its raw material carbide, is used for the manufacture of fertilizers. The use of natural gas and liquid gas is limited to the neighborhood of the producing centers unless the production of steel containers could be increased. But lack of steel makes that impossible. The only substitute fuel available in substantial quantities is charcoal and firewood. As early as 1933 the government encouraged its use, but the real impetus was given by the outbreak of the Chinese war. Until May 1938, when gasoline rationing was introduced, its use was only supplementary to the use of liquid fuel. It was gradually adopted in motor buses operating on fixed routes and the government paid nearly half of the conversion expenses. After the conclusion of the Tripartite Pact the use of substitute fuels became compulsory. But present supplies of charcoal are insufficient to satisfy the increased demand for industrial and mining uses and for burning in households. Production of charcoal even showed a decline, due to a shortage of labor. So firewood, which, from a technical point of view is inferior even to charcoal, must also be used. The Ministry of Agriculture and Forestry which was in charge of charcoal supplies spent some 100,000,000 Yen ($23,500,000) on its purchases in 1940 and planned to expend 205 million Yen ($48,175,000) in 1941-42. It is very doubtful, however, whether larger quantities could be put at the disposal of the transport industry. But the solution of the substitute fuel problem depends not only on the available supplies of generator fuel but perhaps to an even greater extent on the capacity to produce gas generators. A large increase in the output of generators would require great quantities of steel and occupy valuable plant space. In an economy like that of Japan where everything is scarce the use of productive capacity must be carefully balanced between deficiencies in the various branches of the economy. Finally, it should not be overlooked that little is known about the synthetic production of lubricants. This problem has certainly not been forgotten. Lubricants are most likely obtained from the Fischer-Tropsch process, and some quantities from the refining of domestic crude oil. Substitutes in the form of tar oil and animal and vegetable oil are also available. In the long run, however, the lack of high-grade American oils must detrimentally affect the machinery used in industry and transport.

As far as the expansion of refining capacity and the creation of a sufficient tanker fleet are concerned, results were not altogether unsatisfactory. According to latest available information, Japan possesses more than 30 refineries with an annual through-put capacity of 22,000,000 bbl. and a cracking capacity of 5,600,000 bbl. Some of her plants are able to produce aviation gasoline. The size of her tanker fleet increased between 1937 and 1939 from 223,000 tons to 440,000 tons and must be even larger now. This figure does also not include tankers belonging to the Navy. As stated in the Japanese Diet, a fleet of supertankers is an absolute prerequisite to the execution of Japan's oil policy. Under peacetime conditions her fleet would be able to carry between 40,000,000 and 50,000,000 bbl. of oil between Netherland India, British Borneo and Japan. But in war carrying capacity is very much reduced, probably by as much as one-half, not counting losses of tankers which will certainly occur on a growing scale.

Indigenous production constitutes only a small percentage of total requirements. The position in 1940 may be evaluated as follows: Though no official figures are available for the Japanese synthetic production during this year, a statement by the Director of the Fuel Office in the Japanese Ministry of Industry and Commerce early in 1941 is extremely interesting. He said that the government-owned company has so far invested some 150,000,000 Yen ($35,250,000), and private industry some 250,000,000 Yen ($58,750,000) in production of synthetic mineral oils. Investments in 1941 and 1942 will amount to a total of 500,000,000 Yen ($117,500,000) so that by 1942 the country will have spent some 130,000,000 Yen ($30,500,000) more for its oil program than originally intended. But due to the inflation of the Japanese currency and the large increase in costs, especially of imported machinery, actual production will fall appreciably below the planned figures. Supposing that all the plants for which money had been invested until 1940 were in full operation during this year, which certainly was not the case, the total production would not have exceeded 4,000,000 bbl. of synthetic oil, if one takes the British calculation for the cost of synthetic oil production as a basis. If the plants for which investments in 1941 and 1942 were planned, are in full production, Japanese synthetic oil output may reach 10,000,000 bbl. or so. Supplies from other domestic sources in 1940 amounted to approximately 2,600,000 bbl. of crude oil, some 2,000,000 bbl. from the Sakhalin concession, about 3,000,000 bbl. from the shale deposits in Manchuria, and some 500,000 bbl. of motor alcohol. At the very best Japan might have produced some 10,000,000-12,000,000 bbl. of domestic liquid fuel in 1940. The bulk of Japan's supplies therefore had to be covered by imports, mainly from the United States and to a smaller extent from Netherlands India. This is by no means surprising, considering that the original seven year plan, based on peacetime requirements, provided for large imports even in 1943. The development of American exports to Japan since 1936 is shown in an accompanying table. In addition to American shipments another estimated 7,000,000 bbl. were sent in 1940 from Netherlands India and, according to an agreement with the Anglo-Iranian Oil Co., some further quantities, estimated at 1,000,000 bbl. from Iran. Further appreciable quantities were obtained from Borneo and other countries including Mexico which agreed in April, 1940, to export 2,400,000 bbl. of oil to Japan within the next 18 months. In 1940 Japan and her possessions had thus about 46,000,000 to 48,000,000 bbl. of oil at their disposal, of which some 25 percent was produced at home. The rest came from American, Dutch and British sources. The danger in which Japanese oil supplies are in the present conflict with the Anglo-Saxon world is obvious.

Oil has for some time been a most important instrument of policy in relations between the United States and Japan. In July, 1939, the American Government gave six months' notice of abrogation of the 1911 trade agreement with Japan. Since 1940 therefore America has been entitled to enforce discriminative measures against exports to Japan and imports from there. In 1940 exports of aviation gasoline, aviation lubricants, and machinery and patents for the manufacture of these products had been prohibited for every country outside the Western Hemisphere. Only the British Empire has received a general license for these kinds of exports. In the summer of 1941 a decree put the shipments of all oil products under export licensing regulations. Japan, it is true, received an export license, but in July, 1941, when she occupied Indo-China the United States froze all Japanese assets. Licenses became necessary for every single transaction. Exports of low-grade aviation fuel and all crude oil suitable for its manufacture were also stopped. The reasons that impelled the United States to permit oil exports to Japan up

U. S. EXPORTS TO JAPAN, 1936-1940

(Thousand barrels)

	Crude oil	Gasoline	Kerosene	Lubricants	Gas oil	Fuel oil	TOTAL
1936	10,381	1,083	...	308	4,990	4,265	21,027
1937	15,995	1,434	181	444	6,308	4,045	28,407
1938	21,272	1,484	...	307	5,297	3,030	31,390
1939	16,086	1,381(a)	255	514	6,020	3,889	28,145
1940	11,466	3,257(b)	43	819	5,116	2,132	22,833

(a) of which 562,000 bbl. were aviation gasoline.
(b) of which 595,000 bbl. were aviation gasoline.

to that time were effectively explained by President Roosevelt in July 1941. "There was a method in letting oil go to Japan with the hope —and it has worked for two years—of keeping war out of the southern Pacific for our own good, for the good of the defense of Great Britain, and the freedom of the seas." No wonder that Japan made continuous efforts to come to terms with Netherlands India for largely increased oil exports. In 1940 Netherlands India agreed to supply her with some 14,000,000 bbl. of oil per annum (but no aviation gasoline). In May, 1941, this agreement was renewed, but towards the middle of June the general trade negotiations between the two countries were broken off. When America froze Japanese assets in July, 1941, Netherlands India gave six months' notice of discontinuation of the oil agreement with Japan. Japan's contract with Iran was also cancelled by July, 1941. Since that time the oil war has really started.

The oil economy of Japan was thus put on a total war footing even before the actual outbreak of war. Control had been established over production, imports, refining, transport, synthetic oil and marketing. This is, as the German naval expert whom we quoted at the beginning of this article, takes care to point out, a great advantage and even necessary in the case of Japan. But the most skillful and efficient organization cannot bridge the large gap between minimum requirements and actual production. It is true that Japan has accumulated large stocks over a number of years. The trade kept at least six months' supply, and much bigger reserves were carried by the Navy. Storage facilities have been constantly and systematically expanded. Figures for available storage even as early as 1933 mention a capacity of 15,000,000 bbl. It is known that further large tank installations have been built since then, especially in the years 1937-38. It is perhaps interesting to state in this connection that in 1935, the last year for which statistics for such a comparison are available, the export statistics of the United States, Netherlands India, and Russia show shipments to Japan, exceeding the quantity given in the Japanese import statistics by over 4,000,000 bbl. It can be assumed that this quantity was mainly for the Navy's account, and that part of it was refined in the Navy's own installations and stored in its tanks. This calculation does not take into account that in many cases export statistics of the oil producing countries do not show all the quantities destined for Japan. This applies especially to Netherlands India, where large cargos go first to trans-shipment points and are redirected from there to their ultimate destination. Quantities consigned to the great bunkering stations in the Far East may also later find their way to Japan or other countries. Japan is thus certainly prepared to live for a considerable time on her stocks, and will be able to satisfy the vastly increased requirements for naval, air and land warfare in the Far East. According to a recent statement by the President of the Japanese Planning Office, oil for the war machine is assured in the case of an embargo and private industry will also receive enough to satisfy its most essential requirements. But assurance of substantial stocks cannot mean adequate supplies for a protracted war.

Japan has relied on an efficient refining industry, a fast fleet of tankers and large storage to cover a lack of domestic production: above, a refinery at Kashiwasaki in Niigata prefecture.

The whole Japanese oil plan and as a matter of fact the whole Japanese war economy includes the gigantic gamble that Japan will be able within a comparatively short time to conquer new sources of supply. Netherlands India, British Borneo, and perhaps Burma are the obvious immediate objects of Japanese expansive aggression. The struggle for the control of various British and American naval and air bases is only the necessary preparation for the exploitation of the resources further south, of which Japan will be in dire need sooner or later. For Japan's problem consists not only in conquering new oil sources but also in establishing assured transport connections between Japan proper and Southeastern Asia. If Japan could succeed in destroying allied sea and air power in the Far East, she might, perhaps count on another attack in force on the Netherlands India, which would leave insufficient time for effective destruction of oil wells and refineries by the defenders. And it is by no means unlikely that Germany will try at the same time to gain control over the large oil resources in the Near and Middle East and will in case of success share the spoils with Japan.

Such a military strategy is one of the pillars of Japanese oil policy. Her tanker fleet would be ready to ship large quantities of oil to Japan and her refineries, which in the peace years have been carefully adapted to the treatment of the crude oil available in neighboring territories, could refine oil even if the plants in the conquered countries should have been destroyed. At the time of writing Japan has already occupied oilfields in British Borneo. The importance which she attaches to this conquest is shown by a speech of Premier Tojo before the House of Peers. He announced that though the British had destroyed 150 wells and other installations before withdrawing, some 70 wells could be brought into production again within one month. Japan, so he said, could count on some 5,400 bbl. daily from this source. The importance of such "local" supplies for Japan's military operations against the Allies is obvious.

But even if the worst comes to the worst, the economic advantages of Japan's military ventures may still be nullified by a successful naval and aerial strategy of the Allied forces. With determined aerial attacks on oil targets and a concentration of submarine warfare on the tanker fleet conditions may change decisively. The experience of England with a tanker fleet manyfold that of Japan has shown that a concentration on tankers by the enemy may prove effective. Loss in carrying capacity through wartime conditions and sinking of tankers may still prove to be the Achilles heel of Japanese oil policy.

If Japan's expansion plans should fail, an immediate collapse through lack of oil alone can by no means be anticipated. It is true, the war might then enter another phase. Japan's military, air and navy operations would be hampered by lack of oil and her military power would lose much of its offensive strength. At the same time her industry would be affected by the lack of good lubricants and transport difficulties. But certain minimum quantities would always be available and it is interesting to note that the Japanese Navy is quite accustomed to the use of domestic tar oils, to the shale oil from Manchuria and to the fuel oil from Sakhalin, all sources relatively safe.

While the conquest of new oil supplies with assured transport connection might solve the Japanese oil problem if her tanker fleet and oil plants remain intact and thereby prolong the war, the failure to do so would weaken decisively the Japanese industrial and military structure and make final victory for her opponents much easier.

OIL AND THE WAR

By Ralph K. Davies

Deputy Petroleum Coordinator

Events Have Put Industry In Front Ranks Of Conflict And Place Upon It Task Of Feeding Giant Military And Industrial Machine.

THE ADVENT of mechanized warfare has changed many basic military conceptions. Profound as has been the effect of mechanization upon strategy and tactics, greater still has been the change that has come about for those "behind the lines." No longer has the fighting been confined to "the front." "The front" has become universal. Mechanized units roam the countryside; the fleets of the air pour their destructions on cities and factories, and total war has become a thing of dreadful reality. Profound military changes have been brought about by putting men into machines, but even more far-reaching has been the industrial revolution wrought by war. Today, conditions of war have forced the mobilization of industries on an enormous scale. The great basic industries have been harnessed to the war chariot, and our mills and factories have been turned over to pouring out rivers of equipment—aircraft, tanks, troop carriers, trucks, gun carriers, combat cars and the multitude of other mobile equipment that must have one thing above all else before they can be operated—and that thing is oil.

The success of our own military operations, and the success of those allied with us in this war, has come by the force of events to rest in the last analysis with the American oil industry. It is an enormous responsibility that has been thrust upon that industry. The industry must pour out to the war the very life blood that makes the machines of war work. We have long recognized that the side with the sure supply of oil is the side that has the chance of coming out on top and the side without oil is the one whose machines will stop and whose peoples will pay the tremendous price of defeat. Thus the march of events has thrust the oil industry into the front ranks of war. It is up to America's oil men to see that there is a sufficient supply of petroleum and its products where it is needed and at the time that it is needed for our military machine. It is also the responsibility of the American oil industry to see that our enormous industrial effort devoted to war supply is kept provided with the oil that it needs. And on top of that staggering load is the job of seeing to it that the required flow of oil—great in itself—is kept flowing to the normal civilian uses that are so essential to the success of the war effort.

Ralph K. Davies

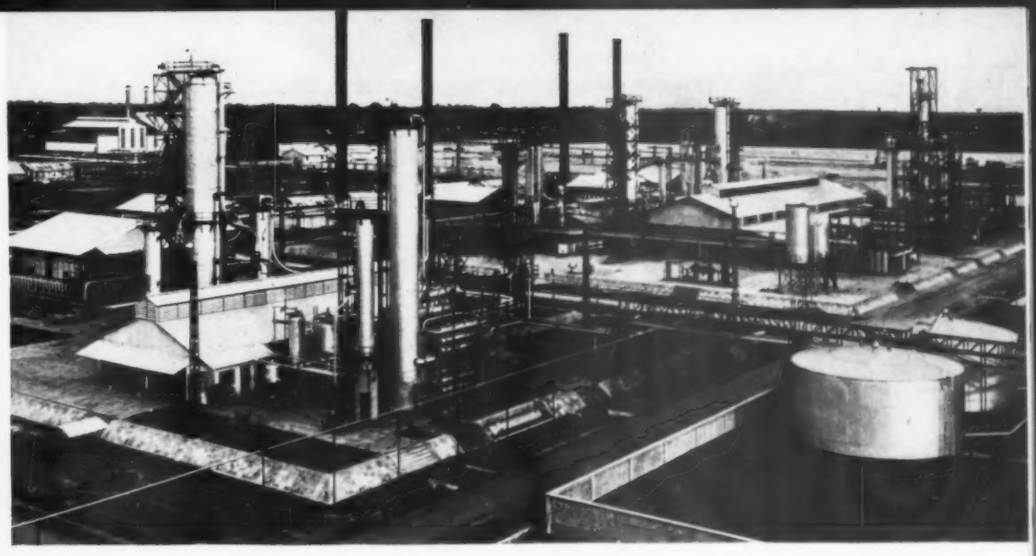
To meet these responsibilities under normal conditions would be difficult enough. To meet them under war conditions, however, when there can be no failure and when the industry, important as it is, becomes another competitor for industrial supplies, is to increase the difficulties in astronomical proportions. This situation was recognized with great foresight by President Roosevelt, and it was to put the industry into a position where it could carry forward under this load that the Office of the Petroleum Coordinator was created. Through this agency, the oil industry has been given a chance to organize for its job. In the OPC, it has an instrumentality within the Government which can aid the industry to direct its own efforts, that can smooth out the worst of the obstacles and can work on behalf of the industry and its needs at the Government council table. It was a dramatic coincidence that on the day this nation declared war against Japan, the leaders of the oil industry of the United States were assembled around the conference table in the Department of Interior Building for the initial meeting of the Petroleum Industry Council for National Defense. The coincidence was heightened four days later when the declaration of war against Germany and Italy found the Executive Committee of that Council assembled in session. But it was no coincidence that both of the meetings had been brought together. The military importance of maintaining the enormous flow of petroleum products made it mandatory that the industry and the Government plot a joint course.

How dependent upon oil are the operations of our military machine is driven home in a recent picture-article in one of the nation's great magazines presenting some of the vehicles of our new Army. In four pages are pictures of 57 different Army vehicles. Forty-seven of the 57 are gasoline or oil powered vehicles and nine are trailers to be drawn by gasoline or oil powered units. In effect, all the vehicles illustrated except for a switching locomotive are dependent upon gasoline and oil for their operation. In war today, 1,500,000 American soldiers would ride to battle in 300,000 vehicles ranging from motorcycles to prime movers. If necessary, it is pointed out, the Army in two years will have 1,000,000 vehicle units—all of them dependent upon gasoline and oil. What greater dependency could be placed on a sure supply of petroleum than the building of such an Army, equipped to move swiftly, anywhere?

Of great concern at the moment in the Office of Petroleum Coordinator is the tremendous expansion—practically overnight—of the production of aviation gasoline. When the manufacturers of aviation gasoline and its components gathered in Washington the day after war had been declared against Japan, they found officers of the Army and Navy waiting to confer with them on this vital subject. How important to the success of our military effort is the aviation gasoline program of the OPC could well be judged from the earnest atmosphere that prevailed at this meeting. Here was no theoretical discussion, no matter of indifferent argument—here were the grim realities of war presenting implacable demands for the finest petroleum products in the world. Out of this meeting had to come the sure knowledge that the industry could supply the fuel that even at the moment of meeting was fighting off the swarming planes of the Japanese Empire over Hawaii and the Philippine Islands.

To supply oil, the industry needs the materials used to bring it from the ground, to handle, store and transport it. In this day of competition for metals and machinery, this means that the need for materials must be judged, weighed against other needs, and determination made as to prior necessity. It is of significance as to the importance of oil that the OPC has been able to persuade the Office of Production Management to set up an allocations system for the industry that can assure supplies and equipment where they are urgently needed.

The war has thrust a great responsibility upon the oil industry of the United States, and the agency through which it is brought into contact with the Federal Government. Today we are fighting for our lives, our way of living, and we are fighting with oil. In that fight, all our individual efforts must be brought together, blended and used most effectively. That job of bringing together, blending and assisting is the job of the Office of Petroleum Coordinator. No more important military contribution can be made by any civilian branch of the Government.



A modern cracking plant at the B.P.M. refinery in Netherlands India. This plant, like others in the islands, probably will be destroyed if defending forces are compelled to withdraw.

Above, a submarine loading line at Sarawak, one of the oil facilities blown up by the British before evacuating this area: Right, drilling rigs at Balik Papan in Borneo that may already have suffered the same fate as the Sarawak fields and refinery.

JAPANESE START HEAVY DRIVE FOR FAR EASTERN OIL

JAPAN'S MASS ATTACK on the Philippines is recognized as the start of a tremendous drive to gain control of the rich oil fields of the Polynesian archipelago. Possession of these important fields would add tremendously to the industrial and military strength of the Nipponese Empire. The yearly production of Netherlands India is over 62,000,000 bbl. That of Brunei and Sarawak in British Borneo is about 7,000,000 bbl. In addition to this insular production the yearly output of Burma which also is threatened by the Japanese is 6,500,000 bbl. yearly. Command of this great oil supply not only would free Japan from past dependence on imports but would enable her to become an exporter.

First of these oil districts to be brought under Japanese domination was that of Sarawak, a principality under British suzerainty on the northwest side of Borneo. A Japanese landing force took possession of Miri, center of the oil fields and site of a refinery of the principal operating company, Sarawak Oilfields, Ltd., during the second week of December and other forces later occupied Kuchang, the capital. This minor conquest will be of no immediate advantage to the invaders, however, as the refinery was blown up and wells, some 400 in number, but many having a depth of only a few hundred feet, were put out of commission. An announcement from Tokio states that rehabilitation of the wells, presumably by new drilling, will start immediately, but this probably will depend on military developments.

Another Japanese attack was launched against Sumatra when parachute troops landed at Medan in the northern part of the island, nearly opposite Singapore. Sumatra is the most important oil producer of Netherlands India with a yearly output above 40,000,000 bbl. and three important refineries. American, Dutch and British interests have been operating there. Months before the outbreak of hostilities it was stated that the refineries in all the islands had been mined and that preparations had been made to destroy the wells in the event of military necessity before invaders could seize them.

NATIONAL COUNCIL Moves Into Action

Organization Representing Oil Industry Forms Executive Committee and Starts Full Mobilization of Country's Petroleum Resources on War Footing.

APPOINTMENT of a National Council of the oil industry announced by Petroleum Coordinator Ickes in November and fixing of the date of its first meeting for December 8 brought leading members of the industry from all parts of the country together in Washington within twenty-four hours after Japan's surprise foray upon Pearl Harbor. The task of mobilizing the oil resources of the country to meet the requirements of a two-ocean, round-the-world war, owing to this fortunate provision, was put into motion without an hour's loss of time.

Organization of the Council was completed in double quick time by the selection of W. R. Boyd Jr., president of the American Petroleum Institute, as chairman and the creation of an executive committee of twenty-five members consisting of John A. Brown, president Socony-Vacuum Oil Co., Frank Buttram, president Independent Petroleum Association of America, H. D. Collier, president Standard Oil Company of California, O. D. Donnell, president Ohio Oil Co., J. Frank Drake, president Gulf Oil Corporation, W. S. Farish, president Standard Oil Co. (New Jersey), W. H. Ferguson, executive vice-president Continental Oil Co., George A. Hill, president Houston Oil Co., Wm. F. Humphrey, president Tide Water Associated Oil Co., J. C. Hunter, president Mid Continent Oil and Gas Association, W. A. Jones, president Cities Service Co., B. A. Majewski, vice president Deep Rock Oil Co., Henry D. Moyle, vice president Wasatch Oil and Refining Co., I. A. O'Shaugnessy, president Globe Oil and Refining Co., J. R. Parten, chairman Premier Oil Refining Co., J. Howard Pew, president Sun Oil Co., Frank Phillips, chairman Phillips Petroleum Co., E. E. Pyles, vice president Hancock Oil Co., W. S. S. Rodgers, president The Texas Company, Charles F. Roeser, Roeser and Pendleton, E. G. Seubert, president Standard Oil Co. (Indiana), H. F. Sinclair, chairman Consolidated Oil Co., Lawrence Vander Leck, president Oil Producers' Agency, R. van der Woude, president Shell Union Oil Corporation and A. L. Weil, former president of General Petroleum Corporation.

The Council is not part of the Office of Petroleum Coordinator but is the oil industry's own organization designed to consider measures for enabling the industry to operate with the greatest speed and efficiency in supporting the national war effort and to act as an advisory and consulting committee in the industry's relations with the representatives of the federal government. The Council will meet once a month or more frequently if necessary and will maintain its own offices in Washington with a secretary in charge.

One of the first steps taken at the initial meeting of the Council's executive committee was directed toward the elimination of all preventable waste. A sub-committee was appointed to report as soon as possible on the nature and character of such waste and to suggest appropriate measures for publicizing the necessity of national conservation of petroleum products. The resolution adopted reads as follows: "Be it resolved that it is the sense of this committee that the emergency facing the country requires the prevention of all waste of petroleum and its products, and be it further resolved that the chairman be authorized to appoint a subcommittee of five members of the council for the purpose of determining the character and nature of such preventable waste, and that this subcommittee report back to this committee, as promptly as possible, appropriate measures to publicize the necessity of a policy of rational conservation of petroleum and its products in order that the cooperation of the public in achieving this end, may be secured."

The Council is expected to play an important role in bringing about prompt and united action in carrying out the extensive operations that are necessary in order to bring about the expansion of exploration, production and refining and the readjustment of transportation facilities required by the existence of a state of war. Members of the Council and other executives spent much of their time during the week following the first meeting in consultation as to means and methods of bringing the industry into high gear in support of the wart effort, and engineering and technical representatives from all parts of the country were summoned to Washington to confer with staff members of the various divisions of the OPC as to increased activities which their individual companies could undertake in this direction. The speed with which the industry moved to place itself on an immediate war footing constitutes a record in industrial mobilization due to the extensive preparatory measures that had been taken.

First meeting of the National Council of the oil industry, appointed by Petroleum Coordinator Ickes, meets in Washington 24 hours after the attack on Pearl Harbor, to mobilize the country's entire oil resources for the military effort. Messrs. Allen, Frey and Gary of the Coordinator's office may be seen in the front row on the left; across the table may be seen, among others, A. L. Weil, General Petroleum Company, H. F. Sinclair, Consolidated, J. Frank Drake, Gulf, and W. S. S. Rodgers, The Texas Corp.

Primary Objective: MAXIMUM PRODUCTION OF 100 OCTANE FUEL

Industry and Government Working Together to Multiply Output of Aviation Super Fuel in Shortest Possible Time—Industry Mobilizing for Superiority in this Decisive Field.

ONE URGENT, immediate and all-important task has been imposed upon the American oil industry by entry of the United States into a two-ocean war. That is a swift expansion in the production of aviation fuel to the greatest extent humanly possible. Aviation fuel means fighting power for bombers, pursuit and all war planes and that means gasoline with an octane rating of 100 or higher. Nothing less will answer because no fuel of lower quality will give army and navy fliers a fair fighting chance in the desperate struggle now under way. This is the word that passed from lip to lip among the oil men who thronged to Washington the day following Japan's dastardly foray on Pearl Harbor and this is the message that has continued to go daily to all members of the oil industry. More 100 octane! More and more and more.

When the national defense program was launched in June 1940 the refiners of the country were asked to double their current output of this high test aviation fuel, raising it to 40,000 bbl. daily. This was accomplished within the year but by that time the call had come to double this production and within a few weeks more the request was to treble it. Nothing illustrates the change that has taken place within the past month better than the fact that nobody now speaks in terms of figures or quotas. With the country launched on an all-out war an all-out effort is demanded and every refiner in the country who can possibly do so is asked to aid this effort in one of three ways.

The first of these is by entering upon the manufacture of 100 octane fuel or enlarging existing facilities for its production. The second is by supplying the materials that give this fuel its superior quality. The third is by refraining from the use in ordinary commercial motor fuel of high octane fractions that are adapted to the production of super fuel for use by the air forces of the Army and Navy.

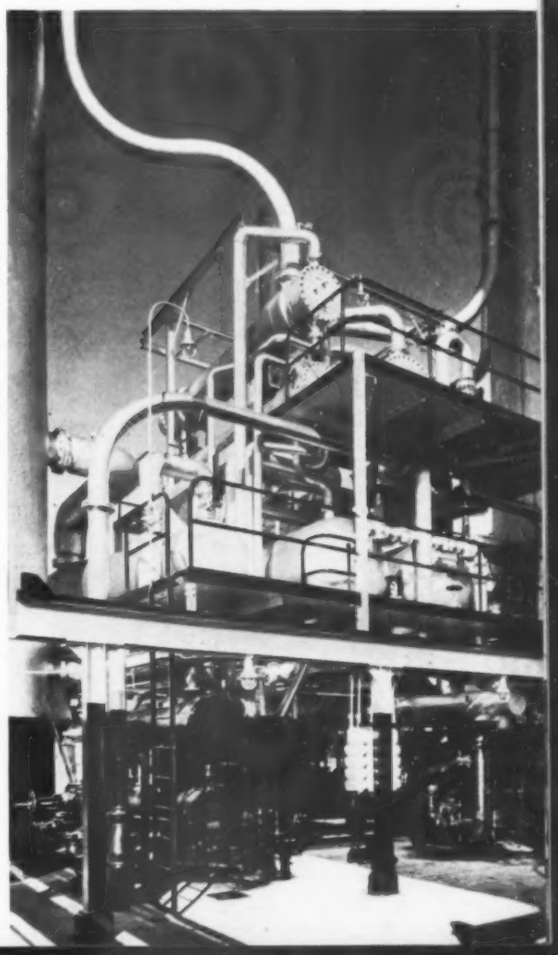
Fortunately for the interests of the country the American refining industry has long been in training for this emergency although the emergency itself was not foreseen. It has developed methods and processes for segregating the constituents of high test aviation fuel and for combining these with high grade blending stocks and tetraethyl lead to produce fuels with octane ratings up to or above 100. While the demand for such super fuels has been limited to military aviation the knowledge gained regarding these blending agents has had a useful application in raising the anti knock rating of commercial gasolines and the research devoted to this subject has put the oil industry in position to undertake a huge expansion in the output of 100 octane gasoline limited only by its ability to obtain the steel, alloy metals and necessary equipment for the construction of manufacturing plants.

Thus the extraordinary task imposed by the war was met by an industry trained to cope with it and a governmental agency that understood the problem and was prepared to cooperate intelligently in its solution. As a result of the preparatory work previously accomplished through this cooperation the coming of war found the 100-octane program far along on its way: a survey had been made to determine capacity and potential increases from existing facilities; a $150,000,000 plant expansion was on blueprints or under actual construction; Supply Priorities and Allocations Board had granted the Coordinator's request for A-1-A ratings on all new 100-octane projects; several large companies had agreed to slash royalties on patents, and so make processes available to others at low cost; and the best brains of the industry were working shoulder to shoulder with government through the Coordinator's National Petroleum Council for National Defense.

Before the war was two days old, the OPC had gained Department of Justice approval for the only remaining step necessary to "full steam ahead," the right to pool and exchange processes, materials and facilities whenever necessary to expedite production of aviation gasoline for the government.

Recognizing that the demand for a vastly increased output of aviation super fuel was one that would be confined largely to the duration of the war emergency and that the facilities brought into existence for this expanded production would be far in excess of ordinary needs the government agencies concerned with the national defense effort agreed that the provision of these facilities called for governmental cooperation. Since the establishment of the Office of Petroleum Coordinator the staff of its Refining Division has been engaged in conjunction with the Office of Production Management, the Reconstruction Finance Corporation, the Treasury Department and other federal agencies in working out specific plans that would meet the requirements of the Army and Navy and of lend-lease obligations as these presented themselves at that time. This program was virtually formulated at the time when the Japanese attack, followed by declarations of war by that country's Axis partners, made it necessary to cast aside the estimates of requirements previously made and to ask for the greatest and most immediate possible increase in aviation fuel production. The plans and procedures already agreed upon were still applicable

Shell Oil Company was the first to complete iso-octane units under the current program. Below is illustrated a unit in the Houston Shell plant.



and the completeness of the preparations is indicated by the fact that the first contract under the enlarged program was signed five days after the initial Japanese attack.

Plans of contractual relationship worked out by the Refining Division of the OPC are designed to fit varying conditions and requirements and can be adapted to almost any set of circumstances under which the production of 100 octane gasoline can be undertaken. For example, a refining company that has ample financial resources of its own and does not stand in need of a government loan can submit a project for a plant or unit to produce 100 octane gasoline or any of its ingredients and a proposal for sale of its output to the government. The offer must be accompanied by detailed plans and information which will make it possible to determine the kind and amount of materials required. The OPC will analyze this prospectus, suggest any changes that it deems advisable and upon final approval of the plans will undertake to expedite its clearance through the OPM which automatically establishes an A1A priority rating for the required materials. A contract for sale of the product of the plant to a government agency at a specified price which is carefully calculated to yield a fair but moderate return on the investment can then be concluded. The price is negotiated with relation to the various elements of cost of the product. Provision is made for price revision in line with changing conditions or alterations in other raw material prices.

If the refiner requires financial assistance in the construction of his plant he may obtain a loan from the Reconstruction Finance Corporation or its subsidiary, Defense Supplies Corporation, after approval of his plans, up to 75 percent of the total cost. Interest at not more than 3 percent is charged. The term of the contract is three years and depreciation and obsolesence charges are figured on this basis but Defense Supplies Corporation retains the right to renew it for two successive yearly periods, the purpose being to have it extend over the whole war emergency.

The elements that determine the terms of the contract are (1) the cost of raw materials, (2) operating expense, (3) depreciation of investment at 10 percent per year, (4) amortization calculated at 23⅓ percent yearly and (5) contingencies, intangible costs and profit. The depreciation cost of 10 percent will be applied to reduction of the government loan and will enable the refiner to write down his investment correspondingly.

The 23⅓ percent allowed for obsolescence will be placed in escrow and at the end of three years will have amounted to 70 percent of the original cost, covering the remainder of the loan.

At the end of the contract period, if the refiner decides that he cannot make use of the plant, the escrow account will be dissolved, the lending agency retaining whatever is required to liquidate the loan and paying over the balance to the refiner who has no further obligation. It is provided however that before abandoning the plant he shall endeavor to negotiate a standby agreement to maintain its facilities for a period to be mutually agreed upon. If the refiner elects to retain the plant the escrow fund reverts to the government and he is still obligated to repay the balance of his loan, thus paying the depreciated value of the plant. If the contract with Defense Supplies Corporation is extended beyond the original three year period the price paid for the product is readjusted to eliminate the factor of obsolescence.

An alternative arrangement is one providing for the erection of what is known as a defense plant built by the government with its own funds and leased back to the refiner at a fixed rental. The operator then makes a deal with Defense Supplies Corporation or other government agency for the sale of the product. At the end of the contract the plant belongs to the government which may dispose of it in such manner as it sees fit. This plan is designed to appeal particularly to small refiners or groups of refiners who do not have market outlets for the specialized products covered by the agreement but who may be desirous of helping to meet the emergency demand now existing. There are certain places where no one refiner has sufficient output to justify the erection of a plant but where several owners of small plants can pool their production without assuming any obligation beyond the emergency period. In other cases small refiners may be able to make arrangements to deliver their output to larger establishments within convenient distance which have facilities for utilizing it.

While the above are the principal plans of procedure considerable latitude is allowed in the determination of details to meet special conditions. The main objective is to mobilize the resources of the country for the production of aviation super fuel to the highest possible extent and on terms that will protect the individual refiner against loss through an early ending of the emergency or demobilization of the industry at its conclusion. The official attitude is that the government will prevent profiteering but is willing

Above, W. W. Gary, director of the Division of Refining in the Office of the Petroleum Coordinator charged with directing the program of increasing U.S. output of iso-octane by 300 percent. Right, Continental's recently completed refinery at Lake Charles which may be the site of another iso-pentane unit, or may supply charging stock for such a unit in the vicinity.

to assure the operator a reasonable return while relying upon his patriotism as an inducement to undertake a line of activity that ordinarily might not appeal to him.

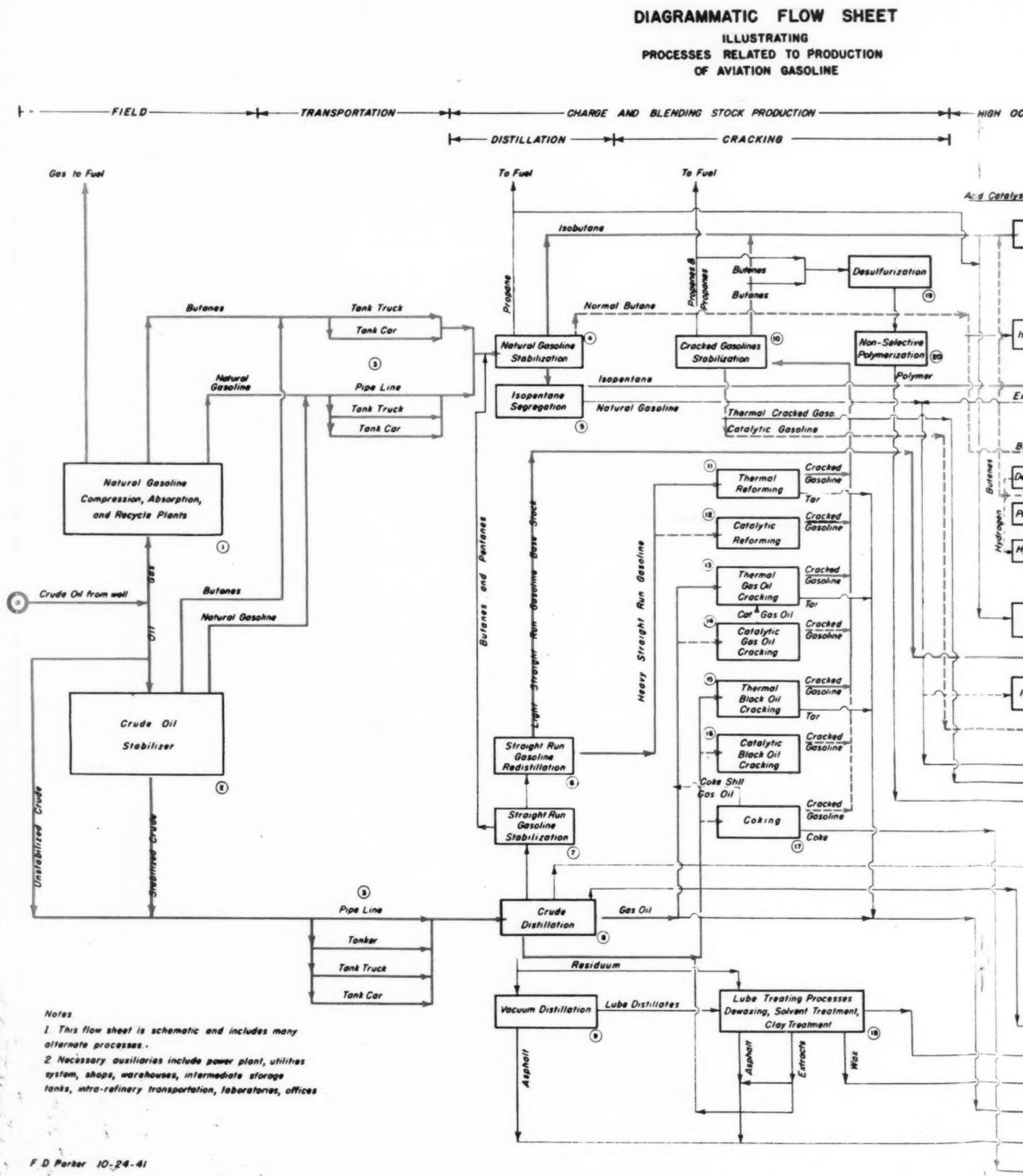
One point which the OPC urges upon the attention of refiners who contemplate participation in the movement for a vast expansion in the output of aviation super fuel is that the more complete and detailed the plans and specifications they submit in relation to new plant construction the less will be the delay in getting official clearance for their proposals. Arrangements have been worked out which will assure prompt action upon all such cases by the various government agencies concerned and full information, forms and instructions will be supplied on application to the Refining Division of the OPC.

Production of 100 octane gasoline has mounted rapidly within the past year and has kept ahead of advance official estimates of probable requirements. Within a few weeks output was increased from 43,000 to 50,000 bbl. daily. Three years ago there was virtually no production of this grade and the growth that has taken place thus far while remarkable under peace time conditions will be swiftly outdistanced from this time forward under the compulsion of the total war effort now required. Twenty-five new plants of large capacity were started or under contract before the Axis assult upon the nation began and output will rapidly rise as these new facilities are brought into operation. All that had been done before December 8, however, is regarded merely as a starting point for the supreme effort that is now to be made by the oil industry backed by the government itself. This effort will continue without abatement until the number of war planes that can be put into service and kept in the air by the United States and the nations fighting with it so far exceeds the combined air fleets of the common enemy that complete victory will be attained.

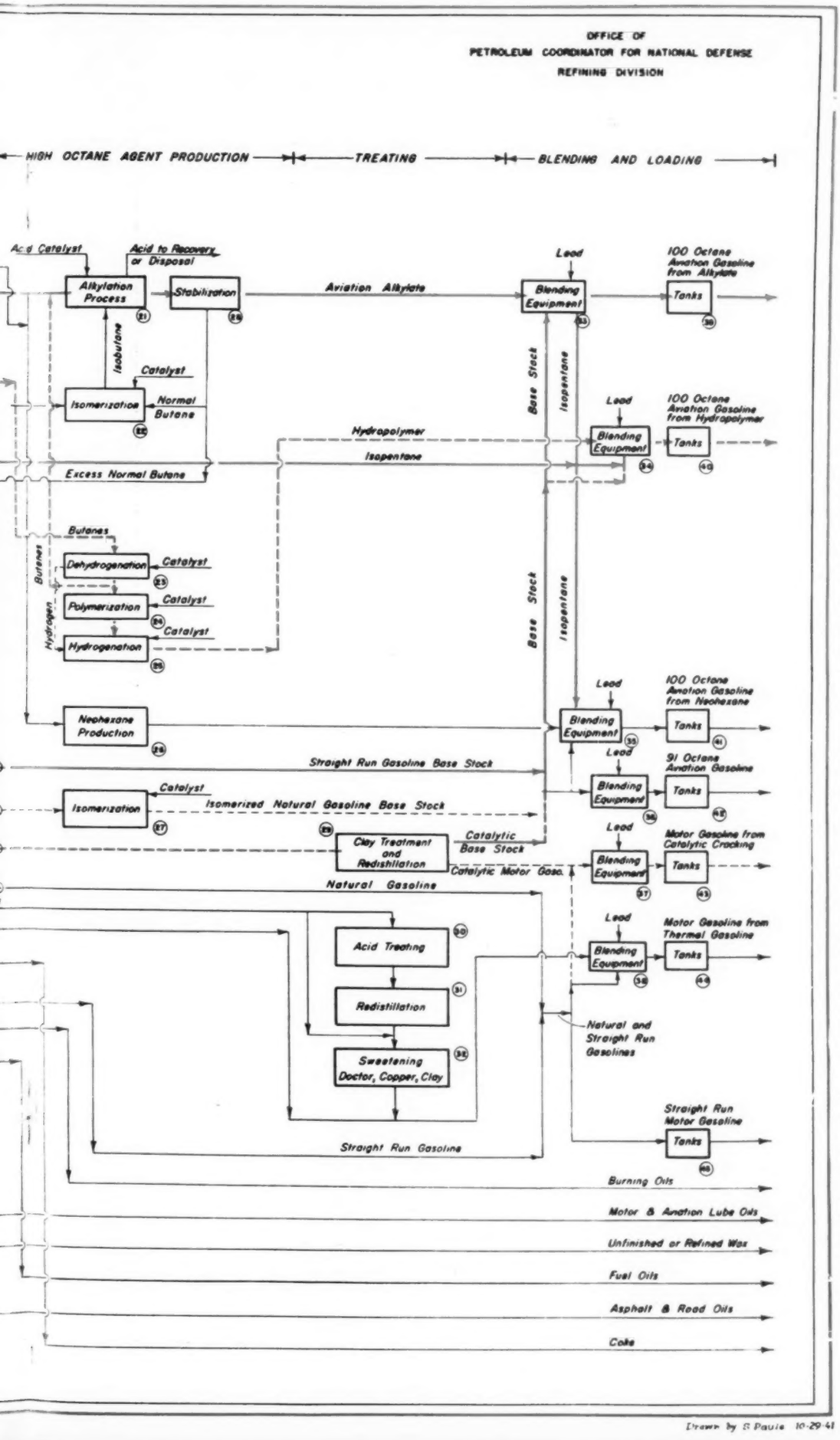
Concentration of effort upon the production of high test aviation gasoline is bound to have effects upon other forms of refining which cannot be fully appraised in advance. With the intensification of industrial activity an increase in the consumption of commercial motor fuel normally would take place in 1942.

At the present time, however, the country's existing refining plant is operating practically at full capacity and the necessity of using available construction materials for war purposes may prevent the enlargement of these facilities. Base stocks suitable for use in the manufacture of 100 octane gasoline must be held for that purpose and the same applies to lead. A decrease in the anti-knock rating of commercial gasoline has been ordered and the possibility of restrictions upon the private use of motor cars or of the rationing of gasoline is one that must be faced. The determination of government officials which is shared by members of the oil industry and which unquestionably will be supported by the public is that the men who are risking their lives against the nation's enemies must have the best and most powerful machines and fuel that it is possible to produce and must receive these in constant and unfailing supply. No other consideration will be permitted to interfere with this paramount necessity.

Relationship of Various Processes Fo



s For Production of Aviation Gasoline



THE CHART at the left was drawn up in the office of the Petroleum Coordinator for National Defense to illustrate the various ways by which aviation gasoline may be produced. This chart is unique in that it includes a number of alternative processes and shows how one or another of these processes may be tied in with the general operation of an average refinery. All these processes have two main purposes: (a) to obtain high grade blending material and (b) to obtain a high grade base stock of gasoline. Refinery construction during the coming year will be concentrated largely on these objectives with a view to supplying high quality fuel for the military air fleet now under construction. This program is described on page 31.

The chart as a whole may be regarded as comprising several areas. In the center area are grouped the processes that yield the base stock. The upper region of the chart indicates the processes that yield the blending agents. The lower region traces the processes that give the regular refinery products, and at the right are shown the blending operations. Everything starts from the crude oil, which is first of all deprived of its natural gasoline and butanes either in a natural gasoline plant or a crude oil stabilizer. These products are themselves stabilized (operation 4), where isopentane is separated; the isobutane, along with isobutene, butane and butene from operation 10 passes through the alkylation process (operation 21) to make aviation alkylate.

In the meantime the stabilized crude oil is topped (operation 8) to take off light straight run gasoline, which is sent to the blending department. The heavy straight run gasoline is either thermally reformed (11) or catalytically reformed (12). The refiner may also choose between thermal or catalytic cracking (13) or thermal cracking (14) for the gas oil, and he has a similar choice for the black oil, or he may run it to coke. The cracked gasolines from these optional operations go to the cracked gasoline stabilizer (10), where they contribute butane and butene for the alkylation or for the hydropolymerization processes, and a cracked gasoline for the treating department (29 to 32). Some of the catalytically cracked gasoline may be added to the aviation base stock. The residue from the straight run distillation is worked up as usual for lubes, wax, fuel oil, etc.

Aviation gasoline (100 o. n.) is shown to be produced either from base stock, alkylate and isopentane (39), from base stock, hydropolymer and isopentane (40), or from base stock, neohexane and isopentane (41). Naturally, the refiner may make various combinations. Tetraethyl lead is used in all cases. A lower grade of aviation (91 o. n.), which is still being used, is made from isomerized straight run gasoline base stock, natural gasoline base stock, catalytically cracked base stock and tetraethyl lead.

U. S. RESERVES Show Slight Increase in 1941

By Michel T. Halbouty

Well-Known Consulting Geologist and Petroleum Engineer of Houston

Anticipates Vast Extension of Exploration to Maintain Reserves In Face of Wartime Demand.

OIL EXPLORATION in the United States shows a definite increase in 1941 over 1940. This is substantiated by the statistics showing the total number of completions for each year. In 1940, 30,041 well completions were recorded as against 31,356 for the year 1941, or an increase of 4.38 percent over the entire year. These completions include oil, gas and dry holes for all parts of the United States. A break-down of these figures shows that 21,733 oil wells were completed in 1941 against 21,072 oil wells in 1940; 2,840 gas wells were completed during the past year in comparison with 2,352 during the preceding year; and 6,783 dry holes were drilled in 1941 in comparison with 6,617 dry holes in 1940. In 1941, there was an increase of 3.14 percent in oil well completions over 1940; also, the gas completions in 1941 are 20.74 percent more than in 1940. Respectively, the dry hole completions are 2.51 percent more in 1941 than in 1940.

Geophysical activity in 1941 was decidedly greater than in 1940. In 1940 geophysical companies were overrun with idle crews. This idleness was due to two reasons: (1) cessation of foreign work because of the war, and (2) a let down in domestic application of geophysics because of the desire of companies to take stock of their existing geophysical prospects. The gradual increase in consumption of domestic crude in the latter part of 1940 and the early part of 1941 automatically increased geophysical exploration. It is reported by geophysical companies that all of their crews are in the field and it looks as if the latter part of 1941 will show a percentage of geophysical crews in the field comparable to the peak in 1939. The Gulf Coast of Texas and Louisiana led in the number of crews working in its area; however, new crews have been placed in every oil producing province in the nation. In a great many instances drilling has followed geophysical surveys and the usual time of one to five years of waiting before drilling a geophysical prospect has been eliminated. It seems as if all companies and all producing provinces in the nation want immediate production, or the proof of new reserves. This kind of activity, with immediate drilling following geophysical surveys, has brought results in 1941 sufficient at least to maintain the balance of reserves for the nation at the end of the year, at or above the reserve figure for the beginning of the year despite record consumption.

Out of the total of 21,733 oil wells which were completed in the year 1941, many new discoveries include new oil fields and new producing horizons in oil fields. As usual, Texas led in the number of new fields discovered, and California was second with Louisiana, Oklahoma and others following in order. Texas maintained its lead in new reserves over the nation by means of a few discoveries in 1941, but mainly through new sands and old field extensions. For instance, in the winter of 1940, the Hawkins Field, Wood County, in East Texas, was discovered; however, development occurred in 1941 to such an extent as to prove many millions of barrels of reserves. In the Gulf Coast of Texas and Louisiana new reserves have been obtained from the development of old piercement type domes, either on the heretofore undeveloped flanks, or from new sands. In the Gulf Coast of Texas and Louisiana a definite movement of independent and major oil companies toward obtaining leases, developing and exploring the old piercement type dome has been observed. It is obvious that prominent geophysical structures are almost extinct and what structures are defined today by geophysical methods are of small relief and small area. The decrease of good prospects has made it necessary for the scientific personnel of the companies to make a restudy of the extensions and possibilities of known structures such as piercement type domes.

In California new discoveries have been made in San Joaquin Valley, in the Coastal districts and in the Los Angeles basin. The greatest activity has been in the San Joaquin Valley. The discovery of new reserves in California has not kept up with the consumption from that state's reserves. It will be necessary in the future to find as much as 225,000,000 bbl. annually in order to maintain the crude oil reserves at a uniform level to meet the present rate of withdrawals.

Discoveries in Louisiana have been higher this year than any previous year and this state has added a large share to the percentage of increase in the nation's reserve. The potentialities in Louisiana are still large and it is likely that many more discoveries will be found in 1942. The greatest activity has been confined to the Gulf Coast, but in central and northern Louisiana activity has increased considerably last year as compared with previous years. This increase in activity has been especially noticeable in Central Louisiana where in the shallow Wilcox trend new fields and extensions have been discovered and the future possibilities for other discoveries still remain. Activity in Mississippi, Georgia, Alabama and Florida increased in 1941 compared to any other previous year. A systematic drilling campaign is in progress in the state of Mississippi, whereas in Alabama, Georgia and Florida, the activity is confined to geophysical surveys and leasing. Several oil shows have been recorded in various wildcats in Mississippi, but it is doubtful that the year 1941 will see more than one new field discovered in that state. Activity in the Mid-continent area has been about level with preceding years and the discoveries have been approximately the same. In this area, extensions and new sands have played an important part in the discovery of new reserves. In Nebraska, drilling is being conducted mainly by the Skelly Oil Company and oil shows reported in wildcats in the Hunton Lime may culminate in the discovery of several new shallow fields. Discoveries in Illinois have been greater in 1941 than in 1940 and the development of these new fields has progressed at a very rapid rate. All phases of exploration are being conducted in the state on a large scale and there is no doubt that many more discoveries will be found in Illinois in 1942. Activity in other parts of the nation have been approximately the same as in previous years. The rate of discoveries in 1941 has been approximately on the same level as 1940. No great oil discovery of a new field in the country has been evident and no one field has materially effected an increase in the nation's reserve. The Hawkins Field discovered in Wood County, in East Texas, in the latter part of 1940, and partly developed in 1941, seems to be one of the largest new fields found in the nation in the past several years. It is evident that a high peak in drilling will be reached in 1942 over the entire nation in the attempt to find new reserves. Drilling in the fall months of 1941 was higher than the rest of the year. In 1941, Texas had a greater number of total completions of oil, gas, and dry holes than any other state in the nation. Total completions for that state were 9,614 wells as compared to 9,055 for the year 1940. The Appalachian area of New York, Pennsylvania and West Virginia had the second highest total completions in the year 1941 with 5,917 for 1941 as compared to 5,850 for 1940. Illinois had the third highest number of completions

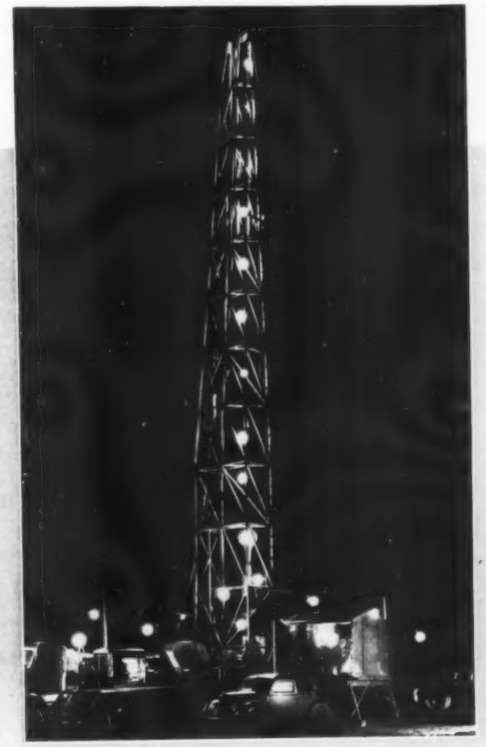
with Kansas, Oklahoma, Louisiana, Ohio and California following in that order. Other states follow in lesser numbers.

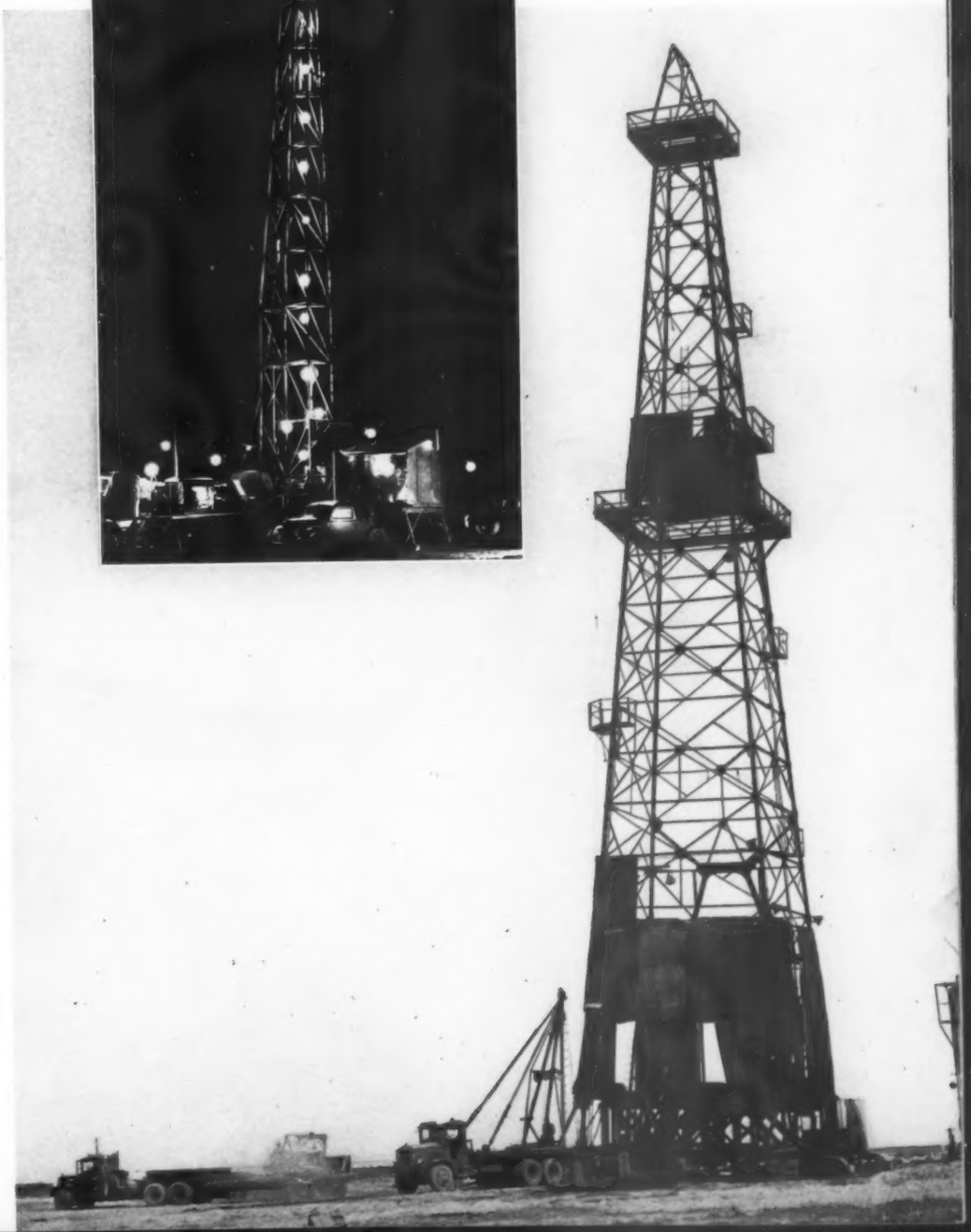
New oil field discoveries in the United States have not been as great as heretofore with the exception of those discovered in the Illinois Basin. Nevertheless, the total proven reserves in the United States will just exceed the figure of 1940. This is made possible mainly through the turning of semi-proven acreage into production and also the discovery of new sands in old fields and extensions to old production. Although 1941 discoveries are still in the development stage, it is estimated that the new reserves from these discoveries will total approximately 2,000,000,000 bbl. The total reserve in the United States at the beginning of the year 1941 was estimated by the A.P.I. as 19,024,515,000 bbl. With approximately 2,000,000,000 bbl. of additional reserves and production of 1,402,288,000 bbl. in 1941, the reserves for the United States at the beginning of the year 1942 may be calculated as being approximately 19,622,227,000 bbl. or an increase of 3.14 percent.

The total production for the year 1940 was 1,350,735,000 bbl., whereas in 1941 the production was 1,402,288,000 bbl. or an increase of 51,553,000 bbl. or 3.816 percent. This increase over a 12-month period was due to the high production figures in the last six months of 1941. This total of 1,402,288,000 bbl. of oil produced in 1941 is a new all-time peak for crude oil production in the nation. In the first few months of 1941, the production was considerably lower than that in 1940. This was due to the gradual loss of foreign markets and a slight decrease in domestic consumption; however, in the middle of 1941, a sharp increase in domestic consumption was evident and shipments of oil to England also increased. This increase was so substantial that in the week ending August 30, United States production, for the first time in its history, exceeded 4,000,000 bbl. per day. In that week the average per day was 4,004,700 bbl. Later, in the week ending November 22, the all-time production peak of 4,336,850 bbl. per day was recorded. In November and December, of 1941, statistics reflected near capacity refinery runs and a close maintenance of a normal situation with regard to stocks of the major petroleum products. In November the daily production averaged 4,115,000 bbl. as compared to 3,512,000 bbl. for November of 1940. This totals 17.1 percent more production in the month of November, 1941, compared with the month of November, 1940. It is only logical to assume that the year 1942 will mark the greatest all-time yearly production the United States has ever known. This production will be due to the new demand which will be created by the war emergency in which this nation is now involved.

The oil industry in the United States must find more reserves in the future and it is predicted that in 1942-1943, the United States will have the greatest demand for oil in its entire history. Even now we are consuming oil faster than we find new reserves. The mechanized army and the two ocean navies must be supplied with oil and its by-products and under war time conditions these military forces will probably account for the major share of the nation's consumption. This demand will force the nation's oil industry to utilize all scientific means in the attempt to discover new reserves. This demand will cause a systematic and prolonged drilling campaign of proven, semi-proven and wildcat areas. The priority for equipment for this development should be ranked among the first after the army and navy and should be granted without any hesitation. The war emergency will cause extensive research in methods of exploration and development in the oil industry which in the end should culminate in new methods of oil finding technique. The industry has never failed to produce in an emergency and no exception is to be expected in this one.

While the need for exploratory work, including the drilling of wildcat wells, and the expansion of production for settled areas to meet rapidly growing demands is greater than ever before, the compelling demand for metals and other materials for direct military use is so great that this must be accomplished with the greatest possible economy of labor and equipment. This is an added challenge to the ingenuity and resourcefulness of the industry and one to which it will not fail to respond. All that it asks is for the indispensable tools for accomplishing its job.





Left, night view of Franks truck-mounted drilling rig in operation: below, rig of the discovery well in the Raisin City field, California, being skidded to a new location.

WAR UNCERTAINTY CLOUDS BRIGHT FINANCIAL OUTLOOK

By Henry E. Rose

Growing Demand, Fair Products Prices Are Assets For 1942: Threats of Tax Revision, Price Ceilings, Other War Measures Constitute Liabilities.

Production is to be stepped up tremendously during the coming year to supply military and civilian needs in the United States and to meet the demands of America's allies. Photo by Cy La Tour.

ATTEMPTS to forecast the outlook for the American oil industry during 1942 are made difficult under present conditions of world unsettlement and many factors of domestic uncertainty. The United States is on a war basis. Oil is vital in modern warfare and whether or not there will be governmental interference in the oil business is not known at this time.

There are some tangible elements present, however, which give a clue to what may be expected, assuming that there are no drastic upheavals. It becomes increasingly clear, for instance, that the industry will be called upon to furnish a new record volume of oil products. This is predicated on: (1) a vastly enlarged war program envisioning more and greater utilization of oil-consuming mechanized war equipment and ships; and (2) the prospect that allied nations, coming within the preview of the Lease-Lend law will require continuing greater quantities of products to fuel their equipment in waging war against the Axis powers. Should these demands materialize, it will mean the performance of a Herculean task by the petroleum industry. Prior to the Far East war development, predictions were that the demand for 1942 would be at least six percent higher than in 1941, which was a record year. Now these forecasts are being revised upward and some foresee an increase of as much as 10 percent. An expansion in volume attaining the latter proportions may strain present facilities of the industry. Military demands, of necessity, will be given priority and there is not the least doubt of the industry's ability to fulfill them. In accomplishing that task, however, it may be necessary for civilians to accept some rationing, especially of gasoline. A 10 percent increase in demand would mean production of crude oil averaging 4,500,000 bbl. daily, a level which geologists (with a few exceptions) estimate represents a maximum without damage to wells, assuring full recoveries from underlying oil pools. That estimate of production is based on potential demand for gasoline, the industry's major product, of an average approaching 2,000,000 bbl. daily. To provide that quantity the industry will have to process at least 4,500,000 bbl. of crude oil, assuming an average yield of 44 percent gasoline from each barrel. Last year's estimated demand for gasoline—domestic and foreign—was 675,000,000 bbl., an increase of more than 10 percent compared with the previous year. The forecast is that the current year's demand will be not less

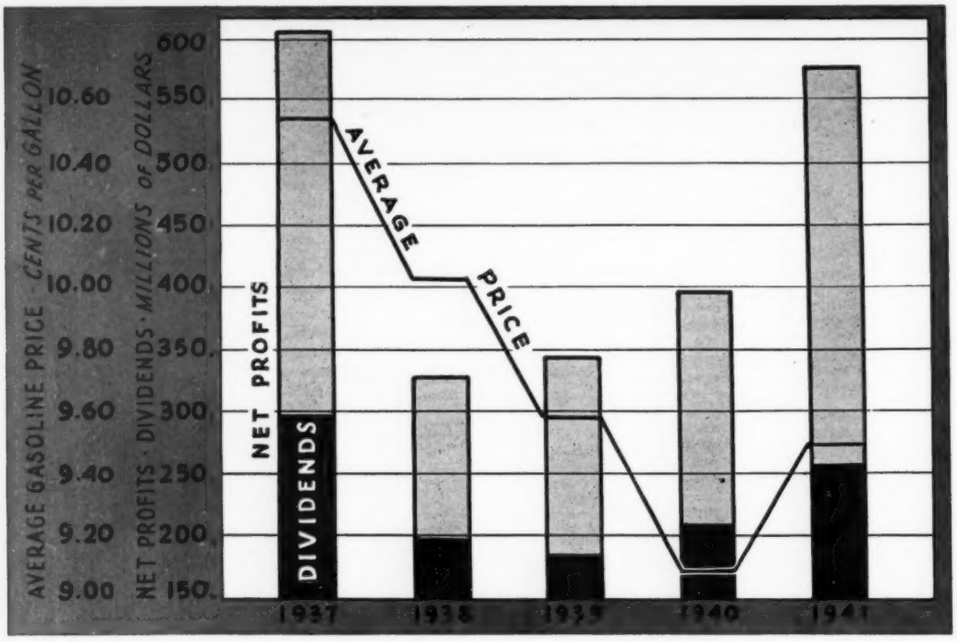
than 720,000,000 bbl. and, probably, greater. The tempo of war activity by Great Britain, Russia, China and other nations which it is the policy of our government to supply in their war against aggression is an uncertain factor in the calculation. Coincidentally, the possibility of heightened activity by Great Britain in the Far East, which gives indication of being a naval and aircraft war, means the need for more gasoline and fuel oils. There is also the prospect of a renewed diversion of American tankers to the service of these nations, with a consequent effect upon transportation facilities in this country. War in the Pacific, it is expected, will require more tankers for fueling operations.

The forecast of so high a demand for oil products in 1942, moreover, dictates the necessity of an exploratory campaign at least as large as in 1941 when approximately 31,000 wells were drilled. In this connection priorities on materials for war goods production may have a bearing. Opinion is fairly general, however, that the industry will experience little, or no, difficulty in obtaining the requisite materials such as steel, well casing, etc. Should the industry have difficulty, its ability to give full cooperation may be disturbed. Only six weeks ago a representative of the Office of Petroleum Coordinator indicated to a meeting of the production division in Texas that more new reserves must be found and developed with much less equipment than has been available. The Office of Production Management, which exercises control over priorities, has developed the idea that there is a super-abundance of oil in the ground and it can be obtained simply by turning a valve. It does not understand why the industry should ask for steel to drill more wells in view of the tremendous reserves and an overabundance of production, waiting only for the demand. Robert E. Allen, director of production in the Coordinator's Office, pointed out recently that unless some of the newer fields "prove up much larger than they now look to be, this tremendous drilling program (over the past five years) has not put the industry in a safe position as far as reserves are concerned. Right now our position as to reserves is not safe in view of the demands that lie ahead."

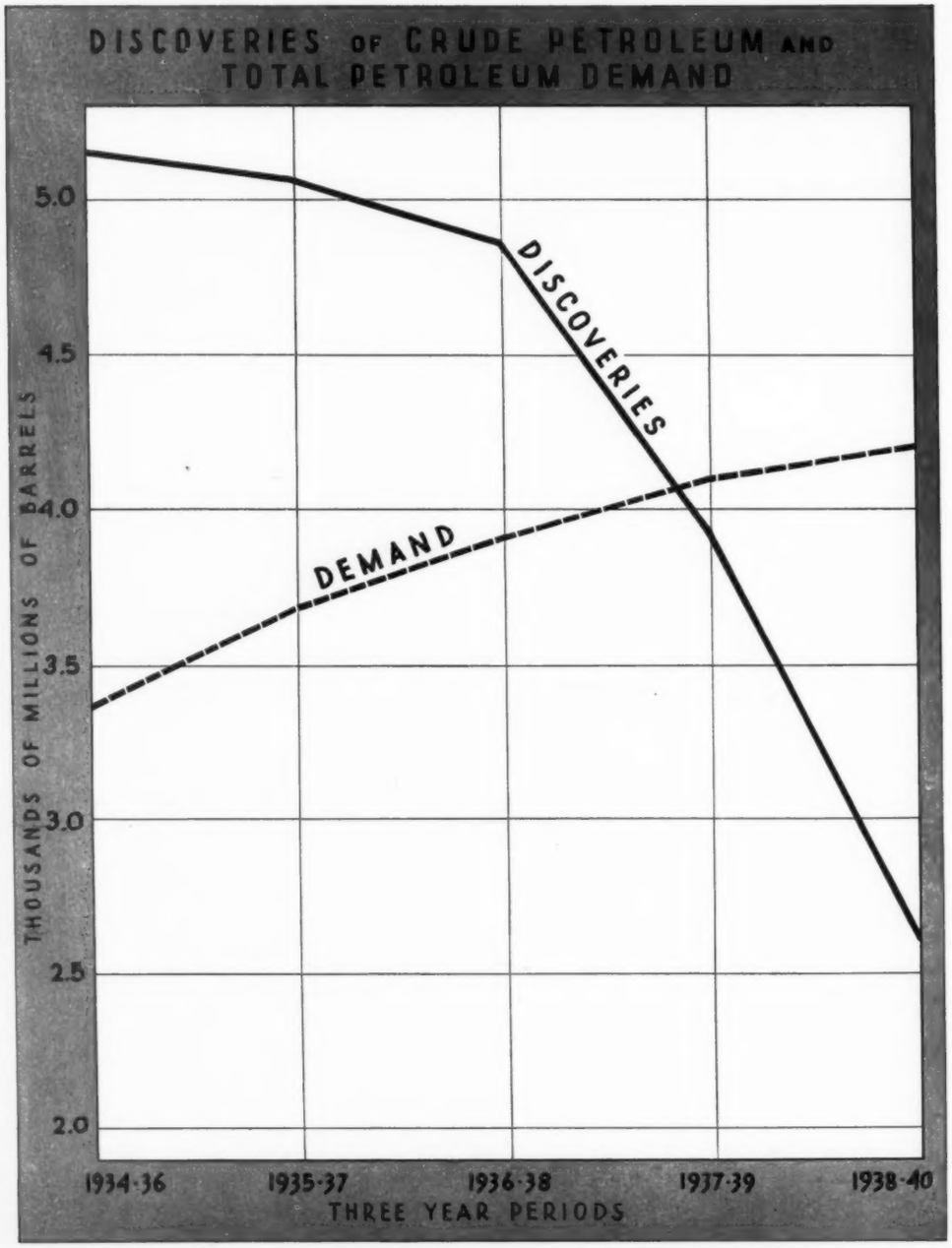
The problem of crude sufficiency, under sound conservation methods, will hinge largely on price to be paid for the oil. Attempts on two occasions during the past year to advance prices in line with higher labor and material costs, and taxes, were frustrated by the government through the Office of Price Administration. The industry, especially independent and small producers, have been clamoring for higher levels for some time. Currently the O.P.A. is engaged in a study of crude oil costs with a view to determining whether or not higher price is justified. One leading independent in the mid-continent, Phillips Petroleum Co., sought an advance of 25 cents a barrel in July and it was requested to postpone the step until October. Early in the latter month it again petitioned but was requested to withhold the advance until the crude cost study could be completed. A survey by the Independent Petroleum Association of America, representing small as well as large independent producing companies, revealed that the present cost of finding, acquiring and producing crude oil approximates $1.52 a barrel against the present posted price of Oklahoma and Kansas standard 36-gravity of $1.17 a barrel. Prices, in fact, are below those of 1937—$1.22 a barrel for mid-continent 36-gravity—and based on the Department of Commerce index of commodity prices, well at the bottom of the list. The petroleum products index averaged slightly above 60 percent on the 1923 level (100 percent) compared with the general commodity average of somewhat higher than 92 percent. It is axiomatic that if the price of crude oil is not sufficiently high to create incentive to drill for new reserves a depletion of reserves must be expected. Based on geological estimates, withdrawals from reserves this year have exceeded new discoveries (not including extensions of, or lower horizons developed in, older pools). The seriousness of this situation becomes more pronounced under present war conditions. Fundamentally, the price situation seems to resolve itself into whether or not a higher price should be permitted to encourage the development of new reserves and thus assure the successful prosecution of the war against Japan. Prices of refined products, for the time being, also have been frozen by the government as of recent date. Any advances must receive the approval of the O.P.A. The industry must prove that essential costs warrant higher levels. It was fortunate that prices of principal products had an upward swing before the present method of government control was adopted. Gasoline, as an instance, currently is at the best level since September, 1938.

Transportation may again become an acute problem for the oil industry requiring the service of numerous tank cars.

Higher product prices, together with two moderate advances in crude prices—averaging 15 cents a barrel—and a record volume of sales, enabled the industry to expand its profits approximately 45 percent compared with 1940, and to approach within a few percent the record year of 1937. For 23 leading American companies used in WORLD PETROLEUM's compilation, the indications are that 1941 net profits aggregated $575,000,000. This would compare with $397,000,000 in 1940, and $607,000,000



Above, net profits, and dividend payments of 23 leading oil companies in the United States in relation to average gasoline prices in cents per gallon on a net dealer basis.



AVERAGE SERVICE STATION GASOLINE PRICE: 50 CITIES

(Cents Per Gallon)

	1941	1940	1937
January	8.54	9.78	10.21
February	8.54	9.73	10.32
March	8.62	9.61	10.55
April	8.78	9.42	10.63
May	9.40	9.24	10.64
June	9.85	9.00	10.66
July	9.94	8.91	10.51
August	10.04	8.91	10.66
September	10.02	8.69	10.66
October	10.04	8.59	10.63
November	10.02	8.58	10.58
December	10.04	8.46	10.30

(the record) in 1937. The turn for the better in profits came in the third quarter of 1941. Prior to that, in the first six months, profits showed a small reduction compared with the similar period a year ago in reflection principally of lower quotations in the first four months of the year. By May of 1941 the real upsurge in prices got under way and continued until late July. Since then stability has developed, and the government has asked cooperation of the industry to prevent further price rises without first consulting with the O.P.A. The trend is indicated by a profit of $34,561,000 for 25 companies in the first quarter of 1941, down 22.8 percent from the $46,088,000 reported by the same companies for the corresponding period of 1940. For the first six months of 1941, 33 companies including larger units that report only on a semi-annual basis, showed profits of $224,175,000 almost equal to $226,701,000 for the same companies during the first half of 1940. Reports of 25 companies for the first nine months of 1941 and 1940 showed profits of $161,998,000 this year, up 36.6 percent compared with $118,555,000 last year. Profit showings of 33 companies reporting for the first nine months of this year, together with per-share earnings on common stock, are given in the accompanying table, with comparisons for the similar period in 1940.

Currently prices of gasoline, which largely determine profits, are moving contra-seasonally. There appears to be no reason, moreover, for them to soften during this period of normally accumulating inventories. The war economy of the United States and the prospect of an expanding demand for the military, together with a higher domestic consumption, indicate that firmness may continue. The average service station price for 50 leading cities is slightly above 10 cents a gallon, before taxes, or 1.15 cents a gallon higher than a year ago, and at the best level since September, 1938. With governmental control over prices, the industry is reluctant to see lower prices for fear that it may be difficult to restore quotations next spring when the normal heavy demand begins. The gasoline price trend this year, by months, is shown in an accompanying table with comparisons in 1940 and 1937, the latter being a record year for profits. With the expectation that prices of gasoline will hold around present levels, indications are that profits of the industry for the first few months

NET & PER SHARE PROFITS FOR NINE MONTHS 1941-1940

	1941 Net Inc.	1941 A Shr. on Com.	1940 Net Inc.	1940 A Shr. on Com.
Amerada Corp.	$1,817,911	$2.30	$1,324,877	$1.68
Atlantic Refining Co.	9,163,045	3.27	6,560,394	2.30
Barnsdall Oil Co.	*4,453,985	1.97	1,657,737	.73
Continental Oil Co.	8,590,802	1.83	3,299,631	.70
Darby Petroleum Corp.	562,953	1.60	213,892	.61
Derby Oil & Refining Co.	312,788	.97	95,317	.15
Houston Oil Co.	858,571	.44	637,738	.21
Lion Oil Refining Co.	745,063	1.71	459,324	1.05
Louisiana Land & Explor. Co.	889,926	.30	633,350	.21
Maracaibo Oil Explor. Co.	30,639	.09	13,014	.04
Margay Oil Corp.	166,304	1.11	158,928	1.06
Mid-Continent Petroleum Corp.	3,553,398	1.91	2,607,522	1.40
Ohio Oil Co.	7,804,288	1.02	7,153,891	.85
Panhandle Pdcg. & Refg. Co.	200,811	.22	(d) 34,890	...
Phillips Petroleum Co.	12,562,598	2.82	8,778,533	1.97
Plymouth Oil Co.	1,015,924	.98	1,231,188	1.20
Pure Oil Co.	10,045,304	1.78	6,700,000	.95
Quaker State Refining Co.	1,508,454	1.63	244,931	.26
Richfield Oil Corp.	3,365,088	.84	3,066,584	.76
Shell Union Oil Corp.	14,485,985	1.10	12,615,195	.86
Seaboard Oil Co.	878,023	.71	891,859	.71
Skelly Oil Co.	4,027,895	4.10	2,251,905	2.13
Standard Oil Co. (Cal.)	24,613,199	1.89	16,730,170	1.28
Standard Oil Co. (Ohio)	4,464,096	5.31	4,325,603	5.14
Sun Oil Co.	10,597,555	4.11	5,502,352	2.26
Sunray Oil Corp.	623,486	.29	323,002	.12
Texas Corp.	40,063,433	3.68	33,692,712	3.10
Texas Gulf Producing Co.	149,956	.17	324,096	.36
Texas Pacific Coal & Oil	770,131	.87	348,126	.39
Tide Water Associated Oil Co.	9,790,595	1.27	7,057,625	.84
Transwestern Oil Co.	295,043	...	(d) 576,716	...
Union Oil Co.	5,087,577	1.09	3,212,612	.69
H. F. Wilcox Oil & Gas Co.	183,132	.39	72,771	.15

NET & PER SHARE PROFITS FOR SIX MONTHS 1941-1940

Standard Oil Co. (N.J.)	$79,000,000	$2.90	$85,000,000	$3.19
Standard Oil Co. (Ind.)	21,763,134	1.43	20,497,223	1.34
Socony-Vacuum Oil Co., Inc.	18,000,000	.58	22,000,000	.70
Consolidated Oil Corp.	3,471,941	.26	2,080,027	.15

(*) Including a non-recurring profit of $2,514,158 from the sale of Texas leases.

(d) Deficit.

of the new year will show a marked improvement over the corresponding period of 1941. In the early months of last year, in fact, prices were near their all-time lows. The improvement, assuming prices hold, approximates 1½ cents a gallon.

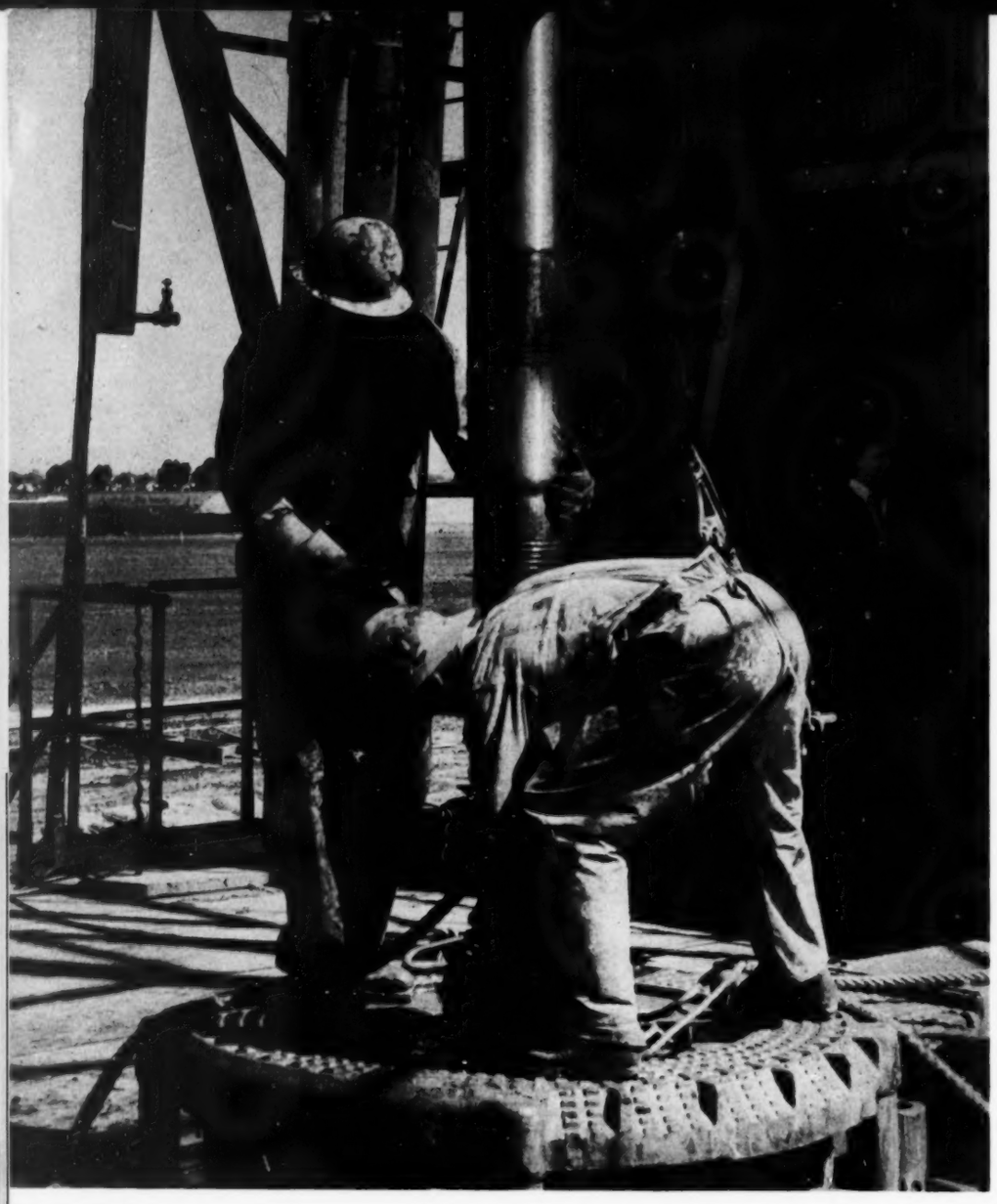
While the inventory position of gasoline today is higher than a year ago, it is not considered burdensome in view of the prospective larger demand. Furthermore, stocks are in strong hands and there appears to be no necessity for distress selling which could exert an adverse influence on prices. The possibility of a materially greater demand for the military, now that the country is actually engaged in war, also acts as a bulwark against price weakness.

The enhancement in profits in the early months of this year will be in face of more onerous taxes and higher labor costs. While the industry, like all others, has been confronted with increased normal income taxes, it enjoys certain allowances as against the purely processing companies. In that respect, hence, it is in a somewhat better position. Engaged in the development of a natural resource, with attendant financial risks inherent in discovery of new reserves, it is entitled to a fair allowance for so-called "intangible development costs" and depletion. These allowances embrace expenses incurred by geological departments, labor, teaming, and other incidental expenses in connection with drilling wells and developing properties. For tax purposes the industry is permitted to deduct depletion of 27½ percent of gross income, but not in excess of 50 percent of net income.

This percentage depletion allowance has been in effect since 1926. On two occasions during the past year the Internal Revenue Bureau has attempted to reduce this allowance by rulings, or interpretations, of the law. One of these differentiated between cost and expense, and the other concerned labor costs where well drilling is undertaken by contractors on a footage basis. Protests from the industry were made and on one occasion, the ruling was suspended and, for practical purposes superseded by another which resorts to the method of calculation formerly used. In the case of contract drilling, however, this has not yet been settled, but the industry expects that it, likewise will be suspended.

Aside from these rulings, the Treasury Department, for years has insisted that the depletion allowance is too high and has characterized it as a "glaring loophole" in the tax laws. Its efforts to persuade Congress to make a change have failed heretofore. The present urgent necessity for increasing governmental revenues from taxes to finance the war may cause new pressure to be brought on Congress to whittle down this allowance. Whether or not the attempt will be successful is problematical. The industry will continue its fight for fair treatment. Reducing the depletion allowance increases the tax burden and correspondingly cuts profits. It is one of the uncertain factors of the future. Another uncertainty is the pattern being developed now by the Federal Petroleum Coordinator to maintain "a better and more definite relationship between petroleum production and consumption, and of determining the proper function of petroleum inventories" during the present emergency. According to Ralph K. Davies, Deputy Petroleum Coordinator, a "long term" program is contemplated. Just when, or how, this will affect the industry is not disclosed. An actual war status, moreover, may change the industry's position in relation to government control. The prospect favors continued private control, however, as indicated by the establishment, last month, of the so-called "Petroleum Industry Council for National Defense." It comprises, for the most part, leaders in the oil industry from various sections of the country. This council, which had its first meeting early in December, has been organized by the Federal Petroleum Coordinator for the purpose of aiding that official "to mobilize the resources and abilities of the oil industry to deal with the emergency conditions under which it must operate."

In line with the improvement in profits last year, cash dividend payments to common stockholders were increased by 21 percent to $255,500,000. This approached within 13 percent the record payments made in 1937 ($293,000,000). Dividends, incidentally, were equal to 45 percent of net profits last year, a slightly smaller portion than was paid out in 1940. Of the 23 leading companies, 13 made larger cash payments, including extras, than in 1940. One, Sun Oil Co., during the year paid two stock dividends, aggregating 16 percent, in addition to the usual cash payment of $1 a share on common stock. In 1940, Sun disbursed an extra stock dividend of only five percent. One company, Consolidated Oil Corp., disbursed a smaller amount on common stock—50 cents against 72½ cents in 1940. The nine remaining companies distributed the same amounts as in 1940. Standard Oil Co. (N. J.) disbursed the largest amount in cash dividends. It amounted to $68,000,000 equal to $2.50 a share on capital stock, and compared with $47,700,000, equal to $1.72 a share in 1940. Other companies distributing larger payments in 1941 were Atlantic Refining which paid the equivalent of $2 a share on common against $1 in 1940; Gulf Oil Corp. $1.50 against $1.25; Mid-Continent Petroleum Corp. $1.15 against 80 cents; Ohio Oil Co. 50 cents against 45 cents; Phillips Petroleum Co. $2.25 against $2; Pure Oil Co. 50 cents against 25 cents; Shell Union Oil Corp. $1 against 75 cents; Skelly Oil Co. $1.50 against $1.25; Standard Oil Co. of California $1.50 against $1; Standard Oil Co. of Ohio, $2.50 against



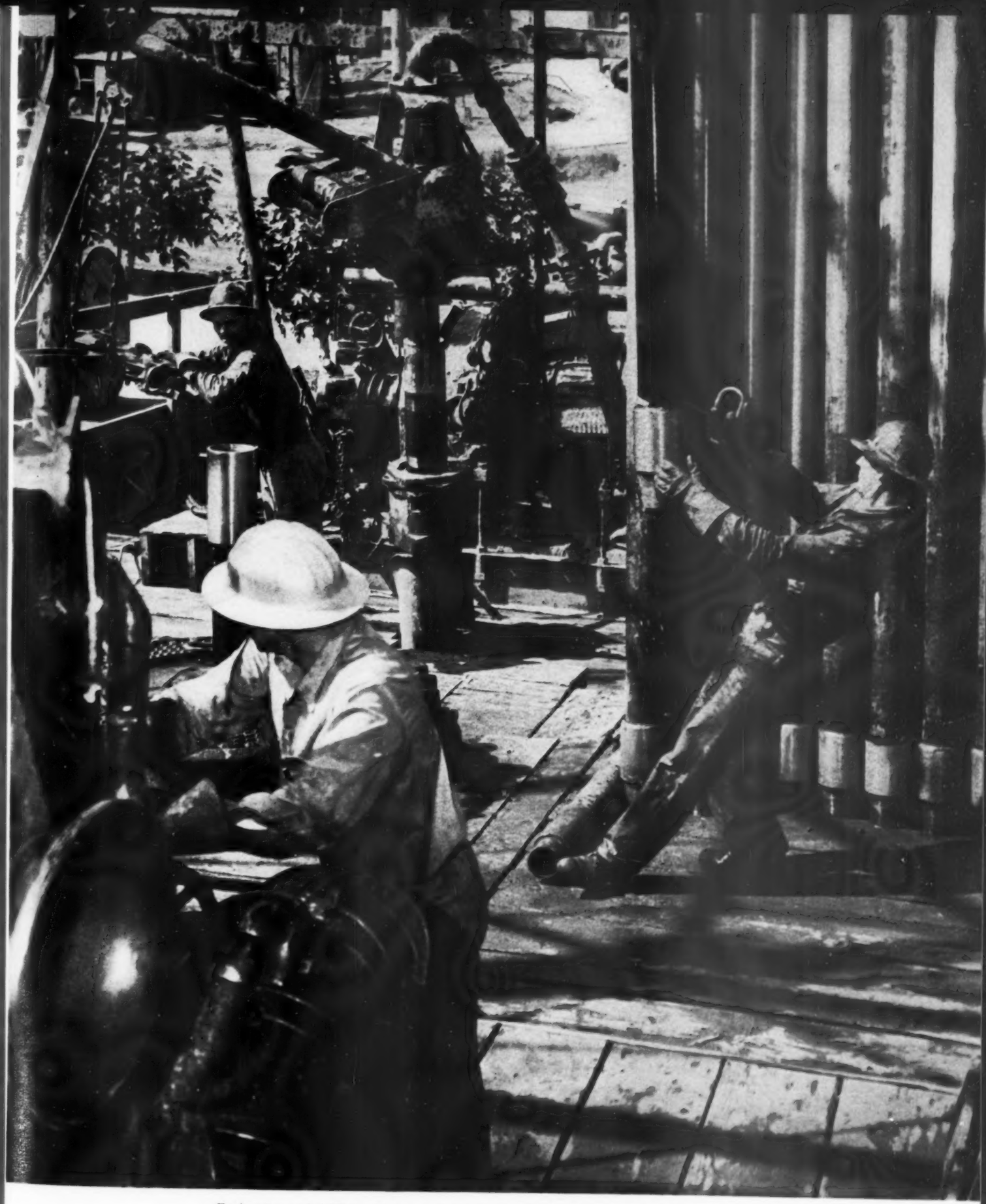
$2; Texas Corp. $2.50 against $2 and Tide Water Associated Oil Co. $1 against 70 cents.

Capital expenditures by the industry during 1941 were at, or near, a record. Aside from an expansion in drilling operations, modernization and construction of new refinery equipment, including that for production of aviation fuels and synthetic products (toluene, alcohol, glycerin and chemicals for synthetic rubber) were large. Moreover, expenditures for new pipelines entailed large, possibly near record, sums. In recent years the industry has been developing into an important producer of synthetic chemicals, using crude oil and refinery gases from which to manufacture tailor-made essential commodities in remarkable variety and volume, especially for the defense program. Toluene, an essential ingredient in T.N.T., and which was difficult to obtain in the last World War, will be produced by the petroleum industry in a volume equal to 70 percent of total production from present plants and those under construction. The industry is making wool oil, used in the manufacture of uniforms, lacquers, aromatic solvents, and numerous other products required in defense. The chemical branch of the industry, moreover, is headed for further rapid expansion. Only the surface has been scratched and there are profits ahead from this important side-line. It has been said often that the petroleum industry is the chemical industry of tomorrow. Synthetic rubber is expected to be an important war necessity now that the country is actually engaged in hostilities in the Far East. Normally the United States obtains 95 percent of its crude rubber supplies from Netherlands India and British Malaya. The war will make shipping more hazardous and the oil industry will be called upon to step up its production of this vital war material. Standard Oil Co. (N. J.), Phillips Petroleum Co. and Shell Union Oil Corp. are leaders in the development of synthetic rubbers, or the chemicals essential in its manufacture and a number of new plants are being pushed rapidly to completion.

Hostilities in the Far East, incidentally, will have a bearing on operations of properties of American companies in that area. Standard Oil Co. (N. J.) and Socony-Vacuum Oil Co., Inc. jointly own the Standard Vacuum Oil Co. which has producing and refining properties there. Other American companies with stakes in the Far East include the Texas Company and Standard Oil Co. of California.

New financing by the industry last year was not unusual, and, in fact, subnormal. There were no large undertakings and for the most part they represented refinancing projects. The lack of new financing was due to improving profits and, hence, better cash positions. The largest undertaking was the offering by Standard Oil Co. of California of $25,000,000 of 2¾ percent debentures and $15,000,000 of serial notes last August. Of the proceeds, $25,000,000 were used to retire 2.15 percent serial notes which were outstanding. Shell Union Oil Corp. as mentioned in mid-year, retired its $33,122,500 of 5½ percent preferred stock, obtaining the funds from an offering of $25,000,000 of low rate debentures and notes, and the remainder from its own treasury cash. Sun Oil Co., on June 1, redeemed its outstanding 100,000 shares of six percent preferred stock and offered holders, in exchange, a new issue of 4½ percent preferred. Holders of 93,136 shares of the six percent preferred accepted the exchange. The unexchanged remainder was redeemed in cash. In March, too, Sun borrowed $10,000,000 from an insurance company, giving a ten-year debenture therefor. Ohio Oil Co., on March 15, last, redeemed an additional 117,416 shares of its outstanding six percent preferred stock, utilizing $9,900,000 of its treasury cash and borrowing the remaining $3,000,000 privately. Its funded debt, in consequence, was lifted to $17,000,000. By mid-year, however, this had been reduced to $15,500,000. Standard Oil Co. of Ohio sold $5,000,000 of debentures to an insurance company early in 1941. Barnsdall Oil Co., with proceeds from the sale of west Texas leases to Stanolind Oil & Gas Co., a subsidiary of Standard Oil Co. of Indiana, reduced its funded debt to $3,400,000, from $7,500,000, the smaller amount also being refinanced at a lower rate. Continental Oil Co. plans to call for redemption next March at least $11,000,000 of its outstanding $21,071,600 of 2¾ percent debentures which are due in 1948.

While a large amount of new refinery construction is under way or being planned for 1942, the greater part of this will be directed to the production of ingredients for 100 octane gasoline or other specialized products required by war activities, such as toluene and butadiene. So far as these plants require financing beyond available funds of the oil companies themselves such requirements will be met by the government through the Reconstruction Finance Corp.



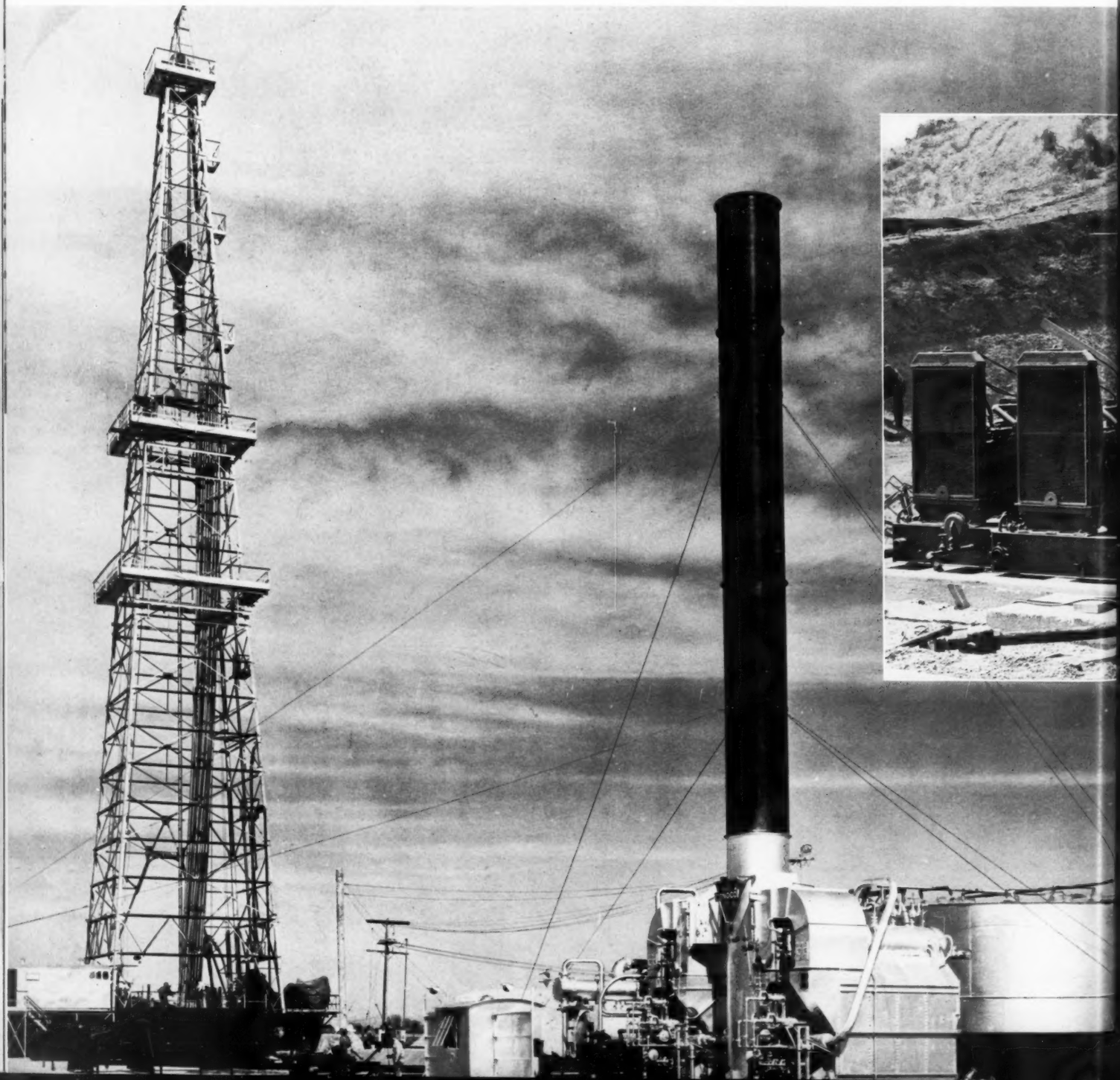
Exploration and drilling will have to be increased to maintain reserves in the face of withdrawals that may reach the staggering figure of 5,000,000 bbl. per day before the end of 1942. Photo on this and the facing page by Cy La Tour.

Advances in 1941 Drilling Equipment

DEMONSTRATED IN CALIFORNIA

By Nicholas A. D'Arcy, Jr.

Emsco Derrick & Equipment Co.



California drilling equipment has changed noticeably within the past year. Light drilling equipment made great strides and many refinements were introduced in heavy drilling equipment. Internal combustion engine power units were practically unanimously chosen by operators in all fields with California operators showing a decided preference for independently powered slush pumps. Increased attention was given to mud pumps and mud conditioning as much of the drilling was in difficult localities.

Three principal types of portable derricks or masts proved their worth in California within the past year. The jackknife type derrick or cantilever drilling mast has been used for drilling wells to approximately 5,000 ft. This type of mast is available in heights up to 126 ft. and can be erected without difficulty by the regular rotary crew. In transporting it over the highway it is necessary to dismantle the mast into several large panels which can be quickly and easily reassembled on the ground by the regular drilling crew. The cantilever type drilling mast does not require guys and is particularly adaptable for deeper wells drilled with portable equipment and for locations where guy lines are difficult to install.

The 90 ft. telescoping and folding trail-mounted portable drilling unit can be transported over the highways with blocks strung up and still meet all California highway requirements. This type of rig requires guy lines and preconstructed deadmen, but the entire drilling unit consisting of mast, finger board, crown block, traveling block, elevating and telescoping equipment, drawworks and prime mover can all be left intact on the trailer. The actual moving time from completion of one well to spudding in the next has not been definitely established, although it is estimated that ten hours will amply cover the entire move under ordinary conditions.

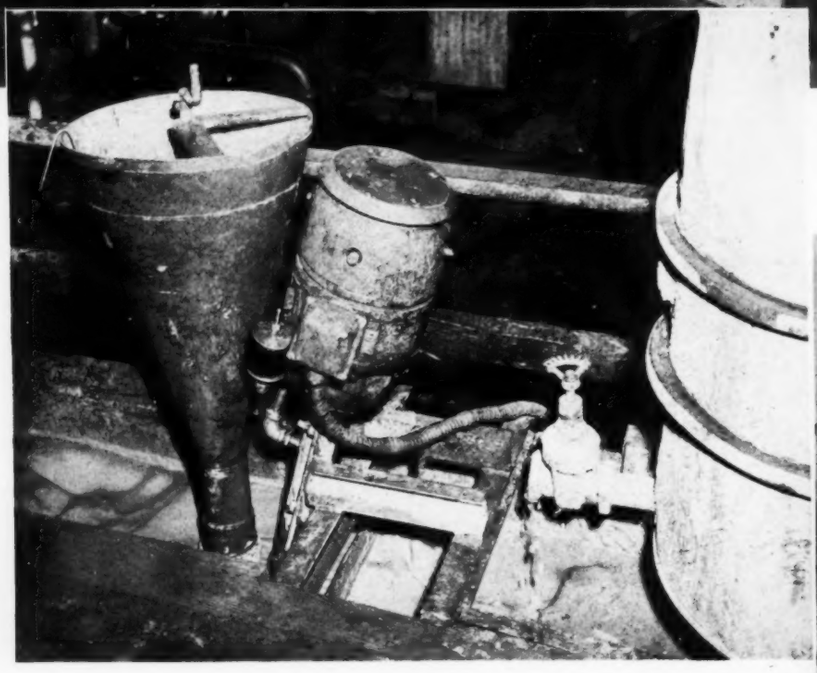
A truck mounted unit made its appearance, consisting of a telescoping and folding mast and hoist, powered by the truck engine. This particular unit has been largely used on production and repair work but is designed for light drilling. This is the lightest of the three units and the one having the smallest horsepower available for hoisting. One major California operator reports that moves are made so rapidly and wells completed so fast with their trailer-mounted drilling equipment that the construction crew has difficulty preparing foundations in advance of drilling operations.

A large three-cylinder steam pump made its appearance in 1941. This pump having an 18 in. diameter steam cylinder, 20 in. stroke, and liner up to 7¼ in. in diameter provides maximum fluid from but a single pump. The pump is designed for 3,000 lbs. working pressure and was actually working against a 2,700 lb. manifold pressure on much of the first hole upon which it was used. It is reported that the three cylinders so smooth out the pumping action that the pump has the appearance of idling even when operating against high pressures at comparatively fast speeds. What is perhaps the world's largest steam pump is also operating in California. The 19 by 9¼ by 22 in. steam pump has a 500 lb. steam end and 3,500-lb. fluid end. It is in operation in the San Joaquin Valley on rigs consistently drilling 13,000 ft. Both the 18 by 7¼ by 20 in. three-cylinder pump and the 19 by 9¼ by 22 in. duplex pump are capable of pumping large volumes of mud under high pressure. This large volume high pressure output from a single pump eliminates the necessity of compounding smaller pumps when difficult conditions are encountered in the course of drilling.

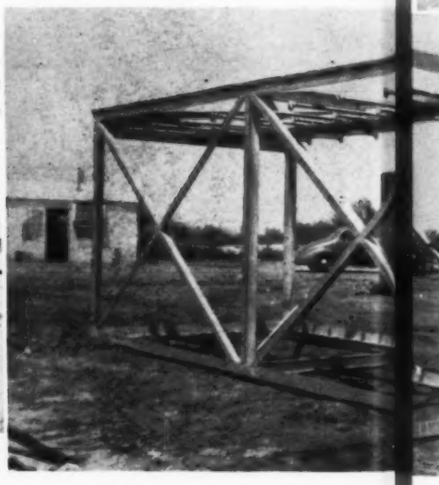
While the mud engineers have been steadily improving the quality of the drilling fluid, equipment manufacturers have been working on machinery for conditioning the mud. The mud disintegrator is a simple and effective machine developed in the field by a competent engineer. It is perhaps the most revolutionary mud conditioning device since the introduction of the shaker screen. The unit consists of several paddles mounted on a rotating shaft which in turn is powered by an electric motor. The mud passing down the ditch is caught by baffles and directed through a section of casing in which the disintegrator paddles whirl. This whirling motion effectively breaks up the colloidal lumps, degasifies the mud and again mixes the mud into a uniform fluid. A hopper mounted on the downstream end of the unit is used for introducing chemicals into the mud stream. An adjustable valve on the bottom of the hopper con-

Left, Continental's test K.C.L. C-2 in California: Boilers with stack at center, surface condenser at left mounted just above feedwater tank; storage tanks with spray nozzles at the top are behind the boilers and cooling towers are at extreme right. Also at left is shown short coupled travelling block and hook showing direct connection. Above is a heavy duty power drilling rig with independent slush pumps driven through special compounding countershafts.

Above, three-cylinder steam pump which effectively replaced two compounded pumps.



Mud disintegrator breaking up colloidal lumps in mud with hopper for introducing chemicals directly to the ditch.



Above right, mud cooling tower showing pipes through which mud passes, and directly above water spray unit to be mounted on top of mud cooling tower.

trols the rate at which the chemical is introduced. The agitation caused by the paddle effectively mixes the fluid. The disintegrator has efficiently added many types of chemicals to the mud, even cotton seed.

A mud cooler was built and used in the San Joaquin Valley with considerable satisfaction. This unit consists of a forced draft cooling tower containing eighty-two three-quarter inch coils through which the discharged mud is passed. These coils are cooled by a spray of water with a large fan forming the necessary draft to provide evaporation. It is reported that mud passing through this cooler will drop eight or nine degrees in temperature and the continued use of the cooler will reduce the mud to a discharge temperature of approximately 105 deg. as compared with 145 deg. to 150 deg. without the cooler. This cooling of the mud provides for much better control and maintains the plastering properties of the mud.

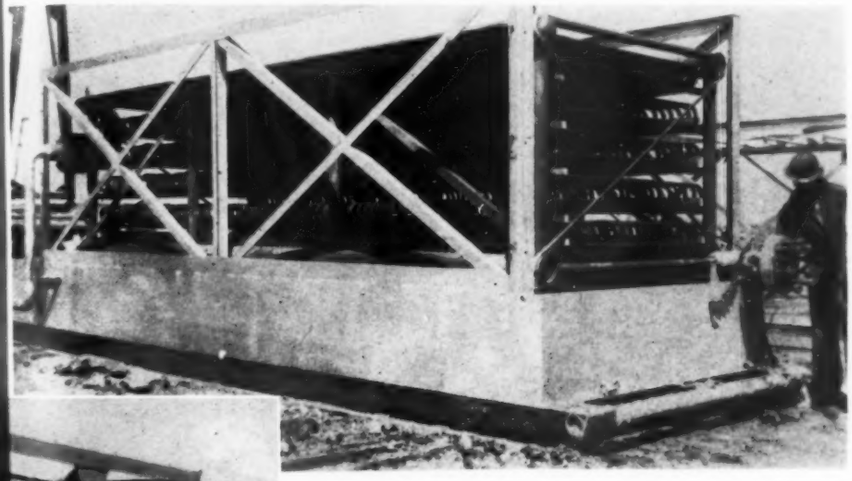
The drawworks development falls into two major classifications. The units designed for use with internal combustion rigs were light in weight, almost entirely equipped with friction clutches and liberally furnished with fingertip controls. The steam drawworks development was one of minor but important improvements. A full hydraulic brake was introduced and the field test revealed it to be a remarkably smooth operating brake. The brake bands were virtually full wrapped having approximately 300 deg. contact. Brake leverage was extremely high and the action smooth but positive. An idea of the power of the brake can be obtained from the fact that the weight of the break lever alone held 5,000 ft. of 5/16 in. drill pipe.

Drawworks drum grooving has long been a serious problem and 1941 saw the introduction of a drum designed to guide wire rope satisfactorily on the third layer. It is also equipped with a taper throwback flange to insure reversal of the

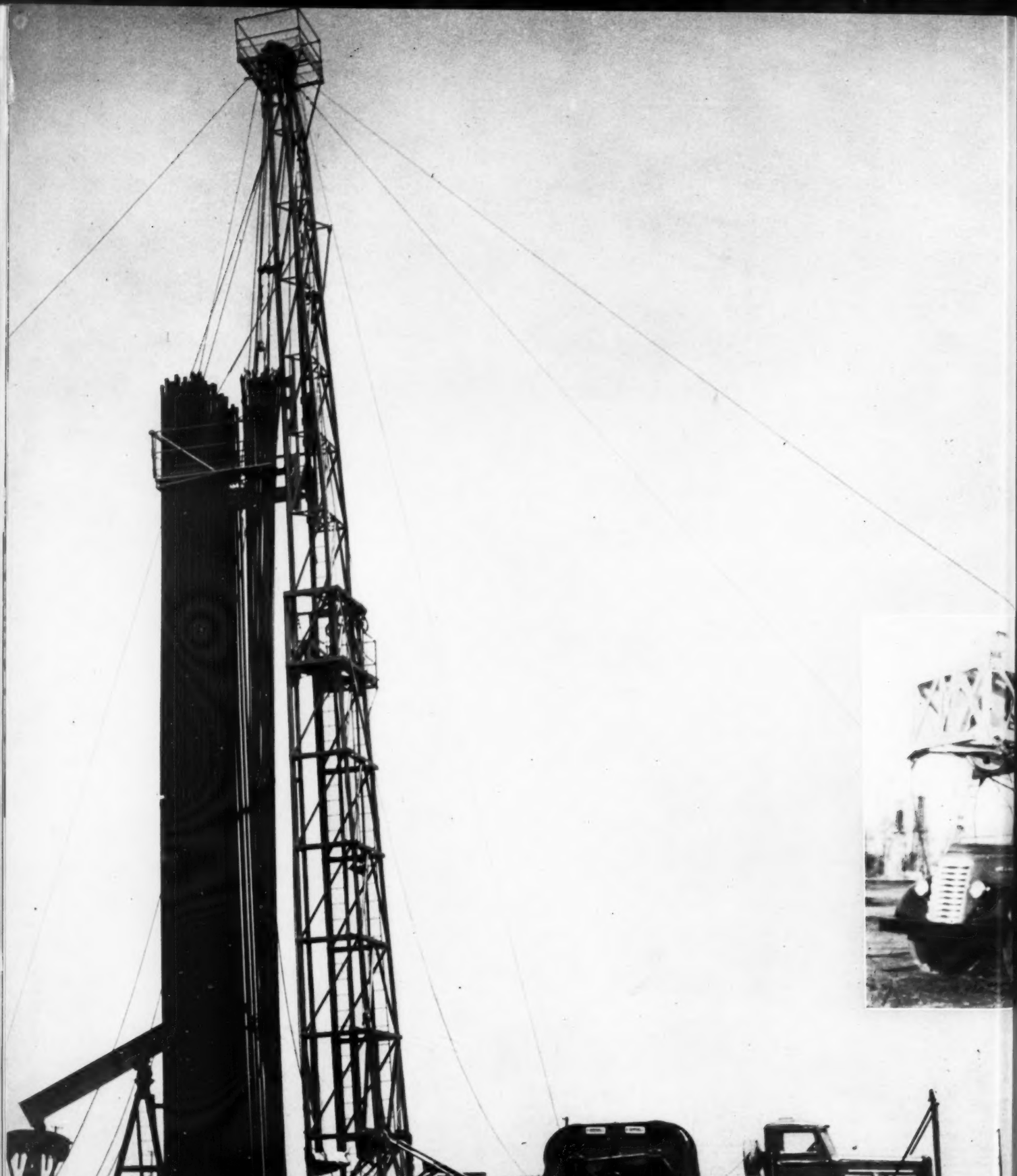
rope at the correct point on the drum, regardless of whether it was a new line or used. The latest drawworks are all equipped with long spooling drums, many of them being forty inches in length. This long drum reduces the number of wraps spooled on the drum and eliminates much of the crushing, cutting, and piling up of wire line encountered with short drums when eight and ten lines are strung. Hydromatic brakes were mounted on extended shafts with a special double taper bushing. This bushing is especially useful when applying hydromatic brakes to worn drum shaft extensions or worn brakes to new drum shaft extensions. The double split taper bushings firmly hold the hydromatic brake as evidenced by the fact that tests have been made operating the hydromatic brake at full load without the customary keys installed between the drum shaft and the brake. Multiple strand chain continued to increase in popularity and the double 2½ in. pitch chain made its appearance on drawworks and slush pump drives. Double two inch pitch chain was extensively used for rotary drives, being especially applicable where high rotary speeds were encountered and oil tight rotary guards were provided.

The outstanding feature in power rigs was the universal acceptance of this type of equipment for new drilling equipment. Two major California manufacturers of both steam and power equipment report sales of seven to ten times as many power rigs as steam rigs. These sales were made in all active fields including California, Mid-Continent and export. The internal combustion engine powered rigs have been greatly refined and 1941 saw the general acceptance of air actuated friction clutches. The past year also saw the introduction of the complete line of large power rigs rated at from 7,500 ft. to 12,500 ft. of practicable drilling depth.

There has been an increased tendency on power rigs to divorce the slush pumps from the drawworks units. Several operators have two complete independent power slush pump setups per rig with one internal combustion engine driving each pump. One California operator has two internal combustion engines ingeniously hooked up to two pumps through a special countershaft. This countershaft is so arranged that the power from the engines can be diverted to either pump and when desired the power of both engines can be compounded into either pump. Although



Right, the assembled mud cooling unit: picture on left shows fan end and the picture on right shows the air intake end.



California operators express a decided preference for independent power driven pumps, other fields have been responsible for the development of multiple engine rigs to power two pumps as well as the rotary machine, and provide for compounding all three engines for hoisting. The engines themselves have received more consideration. One California operator devised a very ingenious automatic spark retarder to be used on his 350 h.p. hoisting engines. An attempt has been made to maintain a uniform temperature in the engines to prevent condensation and dilution of the oil. The temperature has been controlled by means of thermostatically controlled shutters over the radiator and by thermostats in the water circulating system.

An efficient pin drive roller type drill stem bushing made its appearance and received an enthusiastic reception. This type of drill stem bushing eliminates the wear normally encountered when driving the drill stem bushing through the master bushing. All torque transmitted by the rotary machine to the drill stem passes direct from the rotary gear table itself through rubber cushioned hardened steel inserts to large diameter hardened and ground steel pins which are securely fastened to the drill stem bushing. The roller feature of this type of bushing has already met with enthusiastic reception and the addition of the pin drive will go a long way toward lengthening master bushing wear and maintaining concentric backing for the slips.

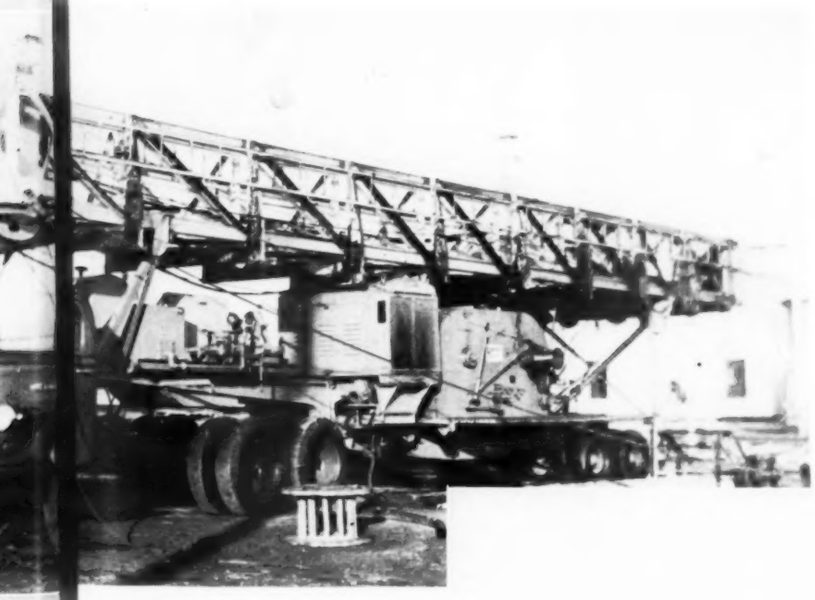
Short coupled traveling blocks were developed as companions to the 90 ft. telescoping and folding drilling masts. These traveling blocks were so arranged that the lower clevis was eliminated and a connector or hook fastened direct to the block. One three-sheave tubing block was adapted to slim hole drilling by the installation of a spring loaded swivel clevis direct to the block. With this setup the distance from the center pin of the tubing block to the bottom of the elevators is reduced by several feet, which is a great advantage in short derricks. The bearings on crown and traveling blocks have undergone radical change. In the modern blocks each sheave is now equipped with a double row of taper bearings designed to take the side thrust as well as the vertical load applied to the sheave. This type of bearing has materially reduced the overall width of the blocks, and eliminated troublesome thrust plates.

Wire line is a major item in the cost of drilling deep wells and drilling equipment manufacturers are endeavoring to increase the life obtained from all wire line. In addition to paying special attention to the spooling characteristics of drums, crown and traveling blocks have been designed with 50-in. diameter sheaves. Approximately 45 crown and traveling blocks having 50-in. diameter sheaves and extremely large and easy rolling bearings are in use in California. Both the 15,004 ft. world's record well, and the 14,622 ft. well, drilled with electric power, were equipped with these new streamlined blocks. Their efficiency and wire line saving characteristics are such that they are also largely used for 8,000 to 10,000 ft. drilling.

Type SA water tube oilfield drilling boilers completed their first deep drilling tests and were successfully moved to a new location in 1941. These water tube boilers are certainly worthy of close investigation for future steam power plants. The water tube boiler power plant in California was in operation 240 days drilling one test well, approximately 12,900 ft. deep. During this period the boilers did not cause a single shutdown and there was not a single boiler maker or boilermaker's helper on the job during that time. A complete elimination of stay bolts, seams, flu sheets, corrosion and scale was responsible for this trouble-free service. The boilers operated on evaporated water, thus eliminating the deposit of scale in the tubes. The evaporator itself was not opened for cleaning during the entire 240 days. It was cleaned by temperature changes and the flushing out of the released scale. Boilers are not yet operating with their recommended size burner, yet they have yielded 300 percent of their rated capacity of steam with 60 percent efficiency and a stack temperature of only 620 deg. The elimination of seams and stay bolts greatly reduces a common boiler hazard and the safety angle of Type SA water tube oilfield drilling boilers should be considered along with economies in operation.

In conclusion it may be said that 1941 has seen portable type equipment leap into the foreground for drilling to depths of 3,500 ft. in California. Heavy drilling equipment has also made noticeable strides, particularly in development of large high pressure slush pumps. Power rigs have been universally purchased when new equipment was desired, ranging in size from 200 h.p. trailer-mounted mast drilling units to heavy three-engine 1,000 h.p. units. All equipment has seen refinements and developments which yield more efficient trouble-free service and faster drilling and also assist in faster rigging up time.

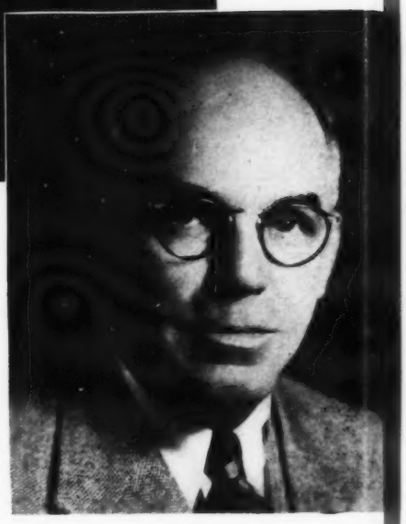
The elements of portability and consequent time saving in moving and setting up rigs, together with other developments referred to above will add materially to the oil industry's ability to meet the heavier demands imposed upon it by the national war effort which calls for an active drilling campaign and increased production.



Left, truck mounted telescoping and folding mast with hoist powered by truck motor: Above, heavy duty telescoping and folding mast ready for moving: Right, cantilever drilling mast in process of being hoisted by drawworks; this rig is used in drilling to about 5,000 ft.

FOREIGN OIL LEGION

Carl A. Nation, foreign department of the Texas Company, now on a six weeks trip to Venezuela and Colombia. Photo by Cosmo-Sileo.



H. B. Kellogg, president of Seaside Oil Company in California.

COLIN E. SPEARING and S. W. Adey of Anglo Iranian Oil Company Ltd., are spending some time in the United States in the interest of their company.

▼

H. B. KELLOGG, formerly Vice-President, has been elected President of Seaside Oil Company of Santa Barbara, California. Mr. Kellogg succeeds to the office vacated by the recent death of M. W. O'Brien. He has been Vice-President of the Seaside Oil Company since September, 1936 and a Director since February, 1937. Mr. Kellogg has been associated with the petroleum industry for more than 25 years. Following a policy of conservative yet progressive expansion, the Seaside Oil Company, under the guidance of Mr. Kellogg and F. E. McClaren, recently elected Vice-President and Sales Manager, has risen to a position of major importance in the gasoline industry in California and Arizona. The election was effective as of December 1st. Present policies of company operation will be continued, it was stated.

▼

S. Storm Jakobsen, engineer for Cia. Nativa de Petroleo (SONJ) returning to the refinery in Argentina after a brief business trip to New York. Photo by Cosmo-Sileo.

GENERAL ELEAZAR LOPEZ CONTRERAS, ex-President of Venezuela, left New York on the SS. Santa Rosa, December 5, en route to Venezuela. General Lopez has been in the United States for several months as a delegate of the Venezuelan Government on matters of continental defense. General Lopez was accompanied by Mrs. Lopez and her mother and sister, Mrs. Teresa Nunez Tovar and Miss Mercedes Nunez Tovar.

CHARLES H. KUNZE, of Brooklyn, N. Y., has been appointed Manager of the Marine Transportation Department of Socony-Vacuum Oil Company, Inc. Mr. Kunze has been with the Socony-Vacuum organization for 38 years, starting as an office boy when he was 16 years old. At that time most of the export shipments were made in packages in sailing vessels. Mr. Kunze has been in the transportation department throughout his career, becoming Assistant Manager in March 1940. As Manager, he has under his direction a fleet of 39 ocean-going tankers flying the United States flag, in addition to some foreign flag tankers, and barges and other vessels for inland waterways.

▼

URAGUAYAN oil men have organized a section of the Instituto Sudamericano del Petroleo—South American Petroleum Institute—with Ing. C. R. Vegh Garzon, general manager of ANCAP refinery, as president and Ing. German E. Villar director of the Instituto de Quinica de la Facultad de Ingenieria, as secretary. The Institute is being organized along lines similar to those followed by the American Petroleum Institute and the Institute of Petroleum in London for the exchange of information among those engaged in the technical operations of the oil industry in South America.

▼

DR. CHARLES E. LUCKE has been appointed Consultant by Chemical Construction Company to aid in the company's extensive defense work. Dr. Lucke, who retired this year from his long-held post as head of the Department of Mechanical Engineering at Columbia University, is widely known as one of the country's outstanding authorities on heat and power. During World War I, he served as a Commander of the U.S.N.R.F. In his association with Chemi-

F. W. Floyd, Standard Oil Company of Venezuela, at the time he sailed from New York on his return to headquarters in Caracas last fall. Mr. Floyd is in charge of producing operations and had completed a month's business trip to the States. Photo by Casmo-Sileo.

Thomas C. Brown, office manager of Lago Oil & Transport at Aruba sailed from New York at the conclusion of his vacation in Chicago aboard the SS. Santa Rosa in November. Photo by Cosmo-Sileo.

Herbert G. M. Fisher, manager at Esso Laboratories of the Process Division of Standard Oil Development Company, leaving New York on a six weeks business trip to Venezuela. Photo by Cosmo-Sileo.

cal Construction Corporation, Dr. Lucke will act as consultant in the selection and installation of power generating and mechanical equipment for the large projects on which the corporation is engaged.

Dr. Charles E. Lucke, consultant for Chemical Construction Corporation.

▼

REX TOWNSEND has been invited by the Bolivian government to act as consultant and assistant to the Minister of Economy during the reorganization of the Bolivian petroleum industry. He will leave for La Paz during the month of January and expects to be in Bolivia about three months.

▼

HAROLD GRAY, London representative for Reed Holler Bit Company, has accepted a commission as Lieutenant in the British Army. Mr. Gray will perform special duties overseas.

▼

LIEUTENANT ROBERT L. SKIDMORE, export manager of the Marmon Herrington Company and a retired officer of the U. S. Marine Corps., who holds numerous medals for past conspicuous service, has just been recalled to active duty.

WORLD OIL PRODUCTION

Figures in U. S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries

	U. S. BARRELS				METRIC TONS			
	November 1941 Preliminary	November 1940	Jan.-Nov. 1941	Jan.-Nov. 1940	November 1941 Preliminary	November 1940	Jan.-Nov. 1941	Jan.-Nov. 1940
United States	124,548,000	106,904,000	1,278,086,900	1,246,329,500	16,851,305	14,464,078	172,924,758	167,951,549
Soviet Union	17,463,870	17,644,000	208,273,870	220,960,000	2,395,592	3,000,000	28,569,799	31,200,000
Venezuela	21,417,300	13,192,632	200,770,654	171,521,396	3,180,000	1,958,817	29,929,301	25,467,171
Iran	6,383,280	6,700,000	71,438,956	72,591,675	846,769	874,787	9,377,308	9,573,546
Netherlands India: Sumatra	3,387,090	3,345,000	37,327,150	37,241,986	433,630	426,300	4,776,903	4,745,909
Borneo	1,200,000	1,070,400	12,607,720	11,917,199	153,629	137,000	1,614,077	1,525,718
Java	574,830	537,600	6,140,790	6,039,862	73,592	69,200	786,553	767,782
Molucca and Other	60,000	60,300	658,780	671,446	7,681	7,700	84,445	85,869
Rumania	2,783,220	3,000,000	32,905,340	39,408,042	377,385	406,779	4,461,739	5,334,454
Mexico	2,730,000	3,365,000	31,799,000	36,839,787	400,881	494,126	4,669,471	5,333,116
Iraq	774,180	1,000,000	9,074,180	23,225,007	103,486	133,672	1,212,935	3,105,206
Colombia	2,131,277	1,597,000	22,293,931	23,663,890	297,249	222,733	2,961,970	3,300,397
Trinidad	1,741,920	1,800,000	19,410,760	18,418,566	244,995	253,165	2,730,062	2,589,753
Argentina	1,780,620	1,795,564	19,801,212	18,771,357	253,649	255,778	2,819,262	2,680,947
Peru	1,110,000	1,000,000	11,698,520	11,985,324	146,534	132,013	1,544,256	1,584,182
Bahrein	462,570	559,595	6,367,570	6,442,370	63,123	76,419	868,910	889,392
Burma	638,700	610,114	7,102,272	7,120,787	88,218	84,408	980,976	983,487
Canada	816,390	893,438	9,091,385	7,979,599	103,950	113,697	1,149,803	1,015,466
Brunei	450,000	472,200	5,086,743	5,256,974	59,086	62,970	673,718	701,036
Great Germany: Old Reich	358,050	380,000	4,067,662	4,363,959	51,201	54,340	581,698	597,250
Ostmark	56,130	59,200	634,239	619,294	8,367	9,390	94,557	104,655
Slovakia and Moravia	8,700	9,800	100,130	108,975	1,281	1,470	14,758	16,366
Poland	225,000	320,700	3,086,400	3,570,756	30,327	43,000	416,001	477,984
Japan	219,960	217,470	2,431,960	2,421,174	31,288	31,000	345,933	345,657
British India	188,240	185,400	2,075,156	2,064,421	25,999	25,600	286,622	284,986
Ecuador	140,447	160,775	1,364,295	2,240,998	18,516	21,196	179,862	295,446
Saudi Arabia	502,260	467,900	5,351,700	4,896,710	68,539	63,400	728,521	663,385
Sarawak	108,390	108,000	1,200,030	1,209,185	13,630	13,370	152,166	155,105
Egypt	629,010	650,000	7,008,650	5,403,367	89,832	92,830	1,000,971	771,684
Italian Empire: Albania	111,270	135,000	1,266,270	1,362,124	16,677	20,233	189,790	203,966
Italy	3,600	4,000	42,174	53,350	477	500	5,244	6,610
France	39,660	40,000	437,582	456,498	5,563	5,610	61,375	63,978
Hungary	219,960	180,000	2,246,260	1,575,000	29,592	24,200	302,209	211,825
Bolivia	9,660	10,000	110,766	100,414	1,251	1,400	14,495	12,849
Other Countries	47,910	47,800	531,280	532,197	6,844	6,800	75,807	75,979
WORLD TOTAL	193,321,494	168,522,888	2,021,890,287	1,996,499,189	26,480,138	23,587,981	276,586,255	273,122,869

Official Crude Oil Production Figures from 1938 to 1940

	Daily Averages Bbl.		Daily Averages Metric Tons		Total Bbl.			Total Metric Tons		
	Jan.-Nov. 1941	Jan.-Nov. 1940	Jan.-Nov. 1941	Jan.-Nov. 1940	1940	1939	1938	1940	1939	1938
United States	3,826,607	3,815,184	517,738	501,348	1,351,849,500	1,264,962,000	1,214,355,000	182,904,869	171,152,192	164,346,325
Soviet Union	623,574	621,713	85,538	93,134	220,600,000	220,866,000	219,194,000	30,260,631	30,297,119	30,067,764
Venezuela	601,109	599,315	89,367	76,021	184,761,241	205,783,650	188,429,050	27,432,998	30,533,706	27,845,286
Iran	213,889	213,250	28,075	28,577	79,151,675	78,151,332	78,320,840	10,443,546	10,367,117	10,358,495
Netherlands India: Sumatra	111,858	111,424	14,302	14,167	40,586,986	41,557,013	34,538,128	5,172,209	5,320,320	4,662,836
Borneo	37,747	37,635	4,832	4,554	12,987,599	13,125,425	12,812,383	1,662,718	1,680,377	1,719,783
Java	18,385	18,083	2,354	2,292	6,514,462	6,568,714	6,955,283	836,982	842,237	933,595
Molucca and Other	1,972	1,966	256	256	731,746	836,144	607,622	93,569	107,047	81,560
Rumania	95,519	98,225	13,358	15,923	42,524,988	46,020,000	48,366,000	5,766,099	6,240,000	6,603,000
Mexico	95,206	94,922	13,980	15,919	40,314,787	39,428,141	38,505,824	5,843,395	5,794,035	5,716,423
Iraq	27,168	27,087	3,631	9,269	24,225,007	30,791,132	32,404,000	3,238,878	4,115,845	4,345,000
Colombia	66,721	66,522	8,864	9,852	25,592,890	23,857,000	21,581,588	3,569,434	3,327,336	3,007,935
Trinidad	58,116	57,942	8,174	7,730	20,218,566	19,270,256	17,736,176	2,842,918	2,710,515	2,472,943
Argentina	59,285	59,108	8,441	8,003	20,616,928	18,738,003	17,076,237	2,936,880	2,657,232	2,432,857
Peru	35,025	34,921	4,623	4,729	12,985,284	13,587,906	15,908,279	1,716,195	1,798,557	2,099,885
Bahrein	19,064	19,007	2,601	2,655	7,095,370	7,588,554	8,297,998	968,502	1,045,391	1,130,784
Burma	21,264	21,201	2,937	2,936	7,730,901	7,872,981	7,499,498	1,067,895	1,087,424	1,039,960
Canada	27,219	27,138	3,442	3,031	8,718,053	7,837,503	6,965,457	1,109,440	997,487	879,921
Brunei	15,229	15,184	2,017	2,092	5,729,974	5,767,227	5,387,214	764,006	768,320	707,123
Great Germany: Old Reich	12,178	12,142	1,741	1,783	4,543,954	4,487,491	3,850,044	653,590	647,337	552,074
Ostmark	1,899	1,893	283	312	718,494	693,247	370,038	114,045	109,904	63,468
Slovakia and Moravia	300	299	44	49	118,775	119,380	132,005	17,836	18,103	19,282
Poland	9,240	9,213	1,245	1,427	3,891,456	3,898,044	3,828,438	520,984	522,874	504,678
Japan	7,281	7,259	1,035	1,032	6,638,644	2,652,930	2,511,184	376,657	379,161	356,328
British India	6,213	6,194	858	851	2,249,835	2,332,467	2,330,209	310,596	322,160	322,125
Ecuador	4,084	4,072	538	882	2,349,015	2,312,118	2,257,278	309,686	306,824	319,877
Saudi Arabia	16,023	15,975	2,181	1,980	5,364,610	3,933,904	495,135	726,785	536,366	66,683
Sarawak	3,593	3,582	455	463	1,317,185	1,329,645	1,624,882	168,475	171,322	200,126
Egypt	20,984	20,921	2,997	2,303	6,053,367	4,608,797	1,561,231	864,514	657,570	223,058
Italian Empire: Albania	3,791	3,780	568	608	1,497,124	1,393,727	437,597	224,199	208,279	65,313
Italy	126	126	15	19	57,350	91,330	106,083	7,110	11,346	13,178
France	1,310	1,306	184	191	496,420	500,815	516,240	69,578	70,478	72,106
Hungary	6,725	6,705	905	632	1,755,000	815,248	330,829	236,025	109,896	42,798
Bolivia	331	330	43	38	110,484	100,885	106,620	14,249	11,998	13,262
Other Countries	1,590	1,586	227	227	579,997	578,036	243,000	82,779	82,300	34,080
WORLD TOTAL	6,050,625	6,036,210	827,846	815,285	2,148,677,067	2,082,452,045	1,995,641,390	293,328,272	284,908,175	280,319,861

Detailed monthly reports were published in February, 1941 issue.

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WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing with Technical and Economic Aspects of the Petroleum Industry — Edited by Dr. O. W. Willcox.

GEOPHYSICS

Gravity Work in Illinois—W. W. Skeeters, in MINING MAGAZINE, Vol. 31 (1941), No. 9, pp. 427-429; 472; 494.

The gravity meter has been in use in the Illinois basin area for nearly three years. It is thought by some to be superior to the seismograph in this area, while others consider it unsatisfactory. It is safe to say that most failures of the gravity meter in this area have been due to the technique employed rather than to any ineffectiveness in the method.

The Illinois Basin presents unique problems in field procedure and interpretation.

The regional gravity is a resultant of the anomalies produced by the regional dip, extreme convergence in the sedimentaries and probable variations in density in the crystalline basement. Consequently the regional gravity frequently shows no evident relation to the known contours of the basin. However the smaller local structure features, in which the petroleum industry is primarily interested usually present definite small anomalies superimposed upon the regional gradients.

The producing structures are, on the whole, of small vertical and horizontal closure. Accordingly the anomalies related to them usually occupy an area of from less than one-half section to three sections and present gravity differences of 0.2 to 0.8 milligals. Consequently ordinary reconnaissance spacing of stations is of little value. Adequate coverage usually calls for about 90 stations per township. If such spacing is used and a high degree of accuracy is maintained in all phases of the work remarkably good results are obtainable over the area. Anomalous areas should, of course, be adequately checked by means of reruns and extra stations.

The Mott-Smith Model C gravimeter is cited as an instrument with which to obtain efficiently and economically the detail required for satisfactory operation in the Illinois Basin area. Its tilt sensitivity of less than 1/20 milligal per minute of arc gives it a great advantage over old type instruments on the frozen ground setups of Illinois winters.

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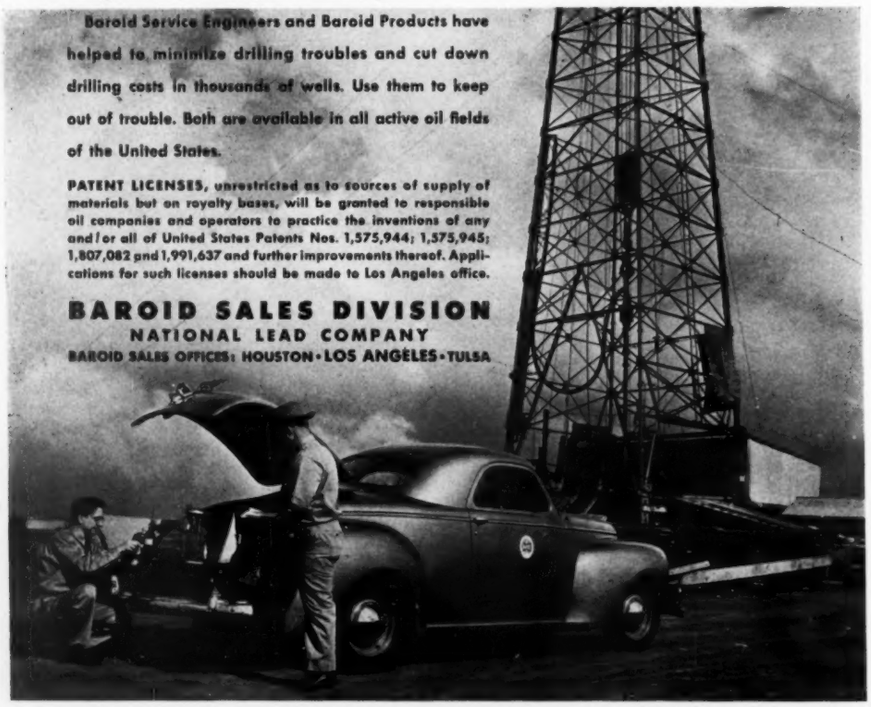

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GEOLOGY

Cementing Materials in Sandstones and Their Probable Influence on Migration and Accumulation of Oil and Gas—W. A. Waldschmidt, in Bulletin AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 25 (1941), No. 10, pp. 1839-1879.

From petrographic studies this author offers some new ideas on the migration of petroleum, and some new hints on how and where to look for oil. It appears that the porosity of a formation may either increase or decrease by processes that go on in and around the sand grains. These changes may cause oil to flow from where porosity is decreasing and creating high pressure, to other places where low pressure is developing.

Other important factors influencing migration and accumulation of oil are of course not discredited, but the writer predicts that if due consideration is given to the study of areas of pressure relief in reservoir sandstones and to the distribution of mineral cements and their control of fluid movements, it will be found that structural or stratigraphic traps, though desirable, are not essential for the accumulation of oil and gas. In other words, oil and gas may migrate either updip or downdip and accumulate in a low-pressure area, or they may also migrate toward and accumulate at a low-pressure area in flat beds.

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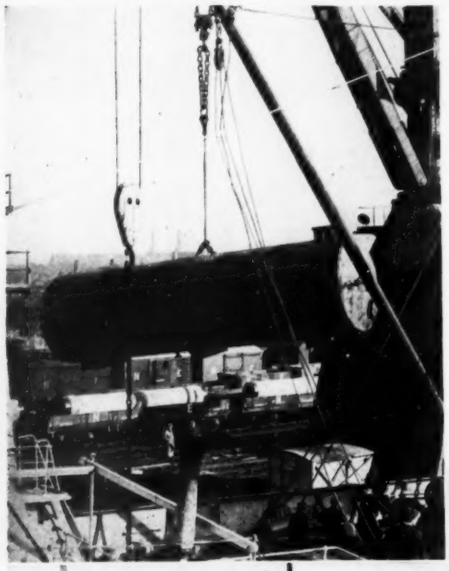

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If these predictions are true, future exploration for oil and gas will have to include petrographic studies of thin sections of outcrop samples, and of samples from productive and non-productive sandstones encountered in wells to determine the nature and distribution of cementing materials. Detailed surface mapping of faulted and fractured areas will be necessary to determine possible areas of pressure relief in underlying reservoir sandstones. Cementation should occur where pressures have been relieved by the development of open faults or fractures, but if evidence of such faulting or fracturing can not be found at the surface, detailed geophysical surveys will be necessary to locate areas of cementation in formations overlying sandstones. Soil-analysis surveys should also be made in areas where evidence of pressure relief has been observed.

From these studies and surveys it should be possible to map the distribution of cementing materials, to determine the probable direction of fluid movement, and to select the areas of pressure relief most favorable for oil accumulation.

DRILLING

Reduction of Hole Size as Affecting Costs, Completion, and Production Practice—I. W. Alcorn and J. U. Teague, before AMERICAN PETROLEUM INSTITUTE, 22nd Annual Meeting, San Francisco, November, 1941.

This paper represents a joint effort of the Southwestern District Topical Committees on Drilling and Production Practice.

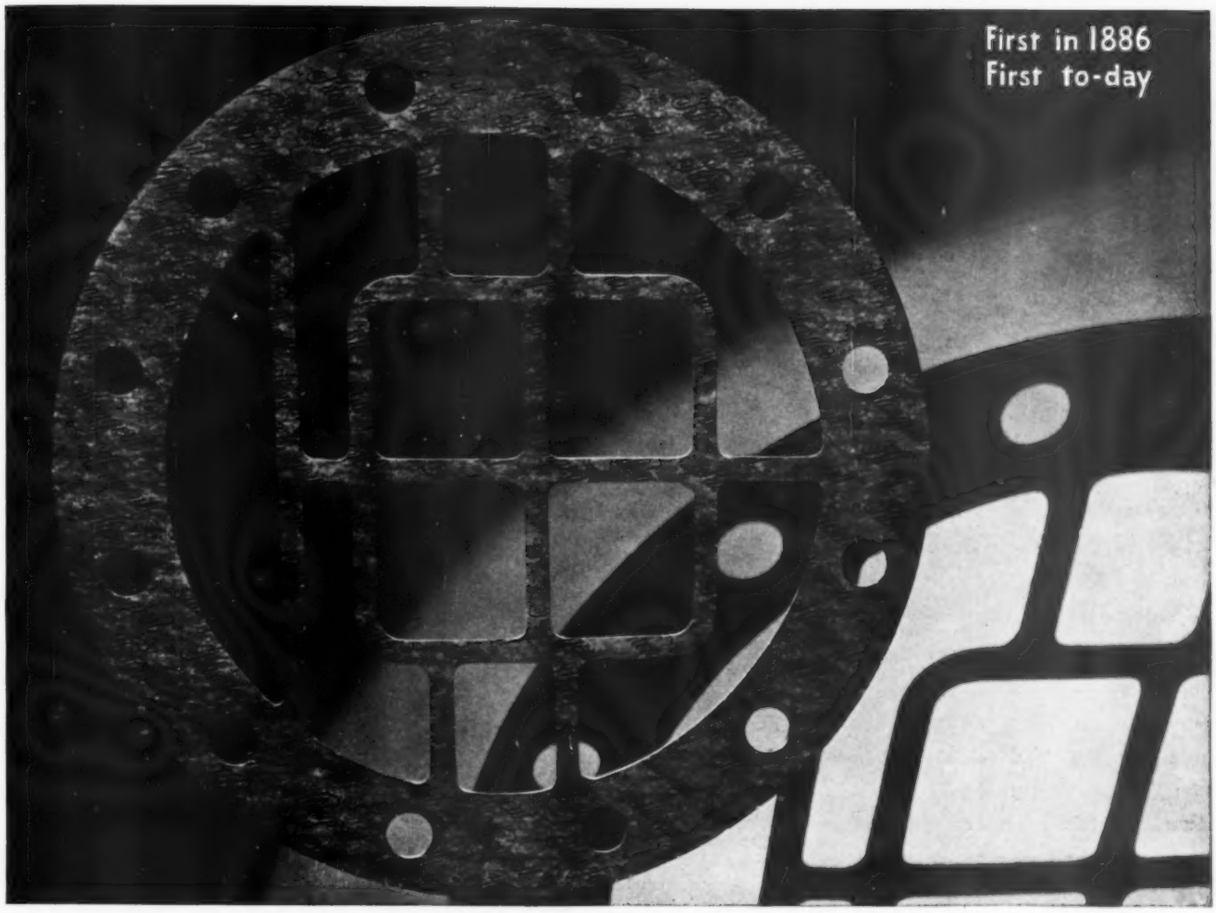
The data submitted on some 2,300 wells from all sections of the country indicate a trend toward the drilling of smaller-diameter holes, both exploratory and proven, and completing wells with smaller casing. Substantial savings are being realized in initial well costs by this practice.

No particular difficulty has been reported in drilling, completing, or producing the small-diameter wells. Nearly all the fields on which data were obtained are in the flowing stage; therefore, little information is available on artificial-lift installation in the small-diameter wells. But the predictions are that no trouble will be experienced with artificial-lift equipment in the small-diameter wells, except when a large volume of fluid will have to be produced with rod pumps.

Small-diameter wells can be repaired by all commonly used methods as easily and cheaply as large-diameter wells, except when the well is to be deepened or sidetracked. Then the small-diameter well is at a disadvantage.

The great majority of the small-diameter wells were completed with 5½-in.-OD casing, which is considered by the majority of those who submitted data to be the smallest practical casing size to use. The popular size hole to drill for setting 5½-in.-OD casing seems to be 8¾-in. A 9⅞-in. hole was drilled for the majority of the large-diameter wells reported, and 7-in.-OD casing was set as the final casing string.

The trend toward the drilling of smaller holes and setting smaller casing probably will continue because of the lower initial well cost, long expected flowing life of most fields, and the low rates of production on individual wells under enforced curtailment of production.



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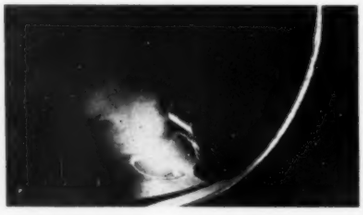

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The costs of the small diameter wells are substantially lower than the cost of large diameter wells in every field on which information was submitted. There was no difference in potentials between small and large diameter wells when taken on chokes ¼ in. in diameter or smaller. Some experiments are being carried out with wells smaller than 5½ inches in diameter.

OPERATION

Control of Gas-Oil and Water-Oil Ratios by Chemical Treatment—Harvey T. Kennedy, before AMERICAN PETROLEUM INSTITUTE, 22nd Annual Meeting, November, 1941.

This paper describes typical chemical treatments for reduction of gas- and water-oil ratios by the plugging of selected portions of the producing formations, and mentions briefly similar treatments applied to cable-tool drilling wells to shut off excessive water. Records of 6 water plugging treatments, chosen to represent various successful treating methods, and 11 gas plugging treatments are included. The latter group consists of all the applications up to the present time of chemical plugging methods to the wells of two major companies in the Goldsmith Pool, Ector County, Texas. Conditions essential for successful application of chemical plugging methods are discussed.

It appears that up to the present time the greatest success has been attained by the use of various silica sols which, on standing one to four hours, became transformed into silica gels whose hardness and setting time may be controlled by the composition and the method of mixing. There are cases for which the method may not be recommended, but where applicable it has given a good account of itself; thus, in the Goldsmith pool, 82 per cent of the wells treated were brought substantially to or below the penalty limit of 5,000 cu. ft. per barrel.

Air-Gas Proves Good Recovery Agent—F. R. Cozzenes in OIL AND GAS JOURNAL, Vol. 103 (1941), No. 11, p. 47.

The forcing of natural gas through a sand body depleted of its original supply, has long been an outstanding method of oil recovery. Unfortunately, however, more than 70 per cent of the eastern stripper-field producers are located in areas where gas must be piped in from outside sources, the cost of this and various other factors making its use prohibitive as a recovery measure. Many producers in such areas have been experimenting during the past five years with air and gas combined. In summarizing results thus obtained, ample proof is found that when an air-gas ratio not lower than 3 to 1 (three parts air, one part gas) is maintained, the producer gets full benefit of air pressure plus a reconditioning of the sandy body resulting from the use of gas. Cost is 40 to 60 per cent less than when gas is used alone, which places the method within the economic range of small operators.

The air-gas method differs but slightly from regular air-pressuring except that gas in required amounts is fed through a jet to the intake of an air compressor, and that traps are placed on the producing wells so that the air-gas mixture can be saved for reuse. On small leases, regular oil storage tanks are used for air-gas storage. There is no set rule which determines the amount of gas fed to the air under pressure, but cost of gas and its limitations must be reckoned with, so the average producer generally adheres to the 3 to 1 ratio.

Where air-gas pressure has been maintained over a period of weeks there is a marked improvement in the quality of oil produced, and the quantity is increased, due to the fact that induction of gas has rendered the sand more responsive to pressure. As a secondary effect, gas tends to prevent the accumulating of wax and paraffin, and aids in breaking down salt, sulphur, and oxide formations which are often caused in the sand by various other recovery measures. Such action gradually brings the sand back into a more virgin state, and so lengthens the life of producing wells.

REFINING

Naphtha Treating "Pays Its Way"—C. F. Mason, R. D. Bent and J. H. McCullough, before AMERICAN PETROLEUM INSTITUTE, 22nd Annual Meeting, San Francisco, November, 1941.

The caustic-methanol process removes essentially all mercaptans from sour gasolines by extracting them with only 2 per cent of strong caustic and a suitable quantity of methanol. The spent reagent is regenerated by steam-stripping and fractionation, and can be used indefinitely for mercaptan extraction.

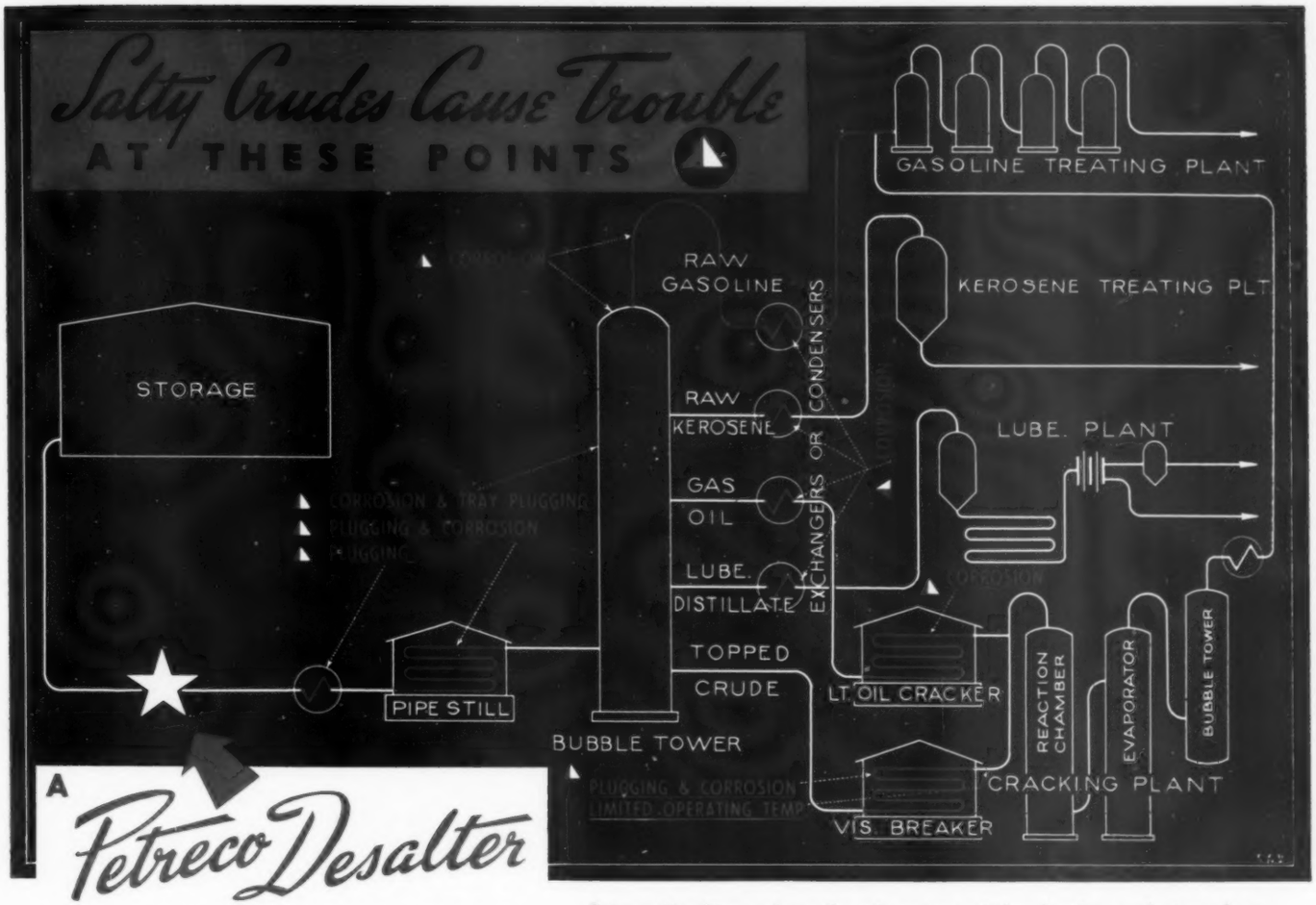
The paper presents pilot-plant studies of the extraction and regeneration steps. Data are given on reagent losses, utility consumption, control of the stability characteristics of the finished gasoline, and improvement in octane number and lead susceptibility over the untreated gasoline. The increase in leaded octane numbers of the treated products usually will offer an attractive saving in lead additions.

The process is ready for full-scale application. Several large plants are under way.

Means of Improving Ignition Quality of Diesel Fuels—E. M. Nygaard, G. S. Crandall and H. G. Berger, in JOURNAL INSTITUTE OF PETROLEUM, Vol. 27 (1941), No. 214; pp. 348-368.

The increasing use of high-speed diesel engines demands fuels of improved ignition quality. The majority of straight-run fuels, excepting those derived from highly aromatic or naphthenic crudes, possess an adequate ignition quality for present-day requirements. However, the increasing demand for high anti-knock fuels for gasoline engines may utilize higher proportions of these stocks in cracking processes. This, coupled with growing markets for diesel fuels of high ignition quality, may necessitate the utilization of stocks of as poor ignition quality as 25 cetane number in the production of diesel fuels.

The refiner has at the present time two distinct problems in order to provide diesel fuels of satisfactory ignition quality: one is the raising of fuels of poor ignition quality (about 25 cetane number) to 50 cetane number; the other is the increasing of fuel of slightly sub-standard ignition quality (40-49 cetane number) to 50 cetane number. A third problem may arise, due either to competition or engine demand—that of producing premium fuels of higher than 50 cetane number. The second and last of these problems may be solved by the use of small amounts of materials added to the fuels to improve their ignition quality. The problem of



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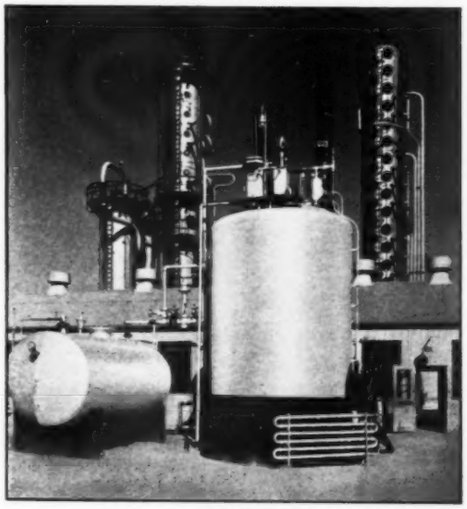

Petreco Desalting reduces the salt content of the charging crude to such an extent that shutdowns, except for periodic inspections, are virtually eliminated. For example, in a Kansas refinery the salt content of the crude was reduced from 70 to 4.5 pounds per thousand barrels. This reduction of salt resulted in a daily throughput increase of 500 barrels.

While on-stream time and increased capacities are always important, our national defense program makes corrosion and metal losses increasingly serious because of the scarcity of the high quality steels and alloys required for replacements. Corrosion and plugging of exchanger tubes; coking, corrosion and metal losses from "rattling" in furnace tubes, are all maintenance expenses caused by salty crudes. In distillation, acids are evolved from the salts in crude oils, resulting in corrosion all through the refinery system.

Petreco desalters are operating in refineries ranging in size from little more than topping plants to large capacity refineries manufacturing all the well known petroleum products. Out of the numerous Petreco installations, every one has justified its installation economically, and many have led to "repeat" installations.

Petreco representatives, with years of experience in combating salt depredations, are always ready to discuss your particular problem. Pilot tests and preliminary estimates entail no obligation.

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DESALTING DEHYDRATING

raising a 25-cetane-number fuel to 50 cetane number is comparable to raising a 24.5-octane-number gasoline to 68 octane number with tetraethyl lead. This procedure would be both impracticable and uneconomical with either gasoline or diesel fuel.

Since the problem of raising a 25-cetane-number fuel to a minimum requirement of 50 cetane number cannot be solved practically nor economically by the use of fuel additives alone, solvent treating, or a combination of solvent treating and utilization of fuel additives, may be a happier, but still costly, solution to the problem. The authors give a long list of patented additives for improving the ignition qualities of diesel fuels. Where large increases in this quality are required, a combination of solvent treating with addition of small quantities of amyl nitrate appears to be the most economical.

Hot Clay Treatment for Removal of Sulfur from Gasoline—Harold Bottomley, before WESTERN PETROLEUM REFINERS' ASSOCIATION, Regional Technical Meeting, Wichita, Kansas, October, 1941.

Attention is called to the fact that on account of the present national emergency, aviation gasoline is very much in demand; hence all methods to produce it should be intensely studied.

Particular attention is called in this connection to many crudes produced in west Texas, New Mexico, and some other regions that are high in sulfur content, and in some cases with a large naphthenic content. The straight-run gasolines produced from many such crudes possess high initial octane ratings, but unfortunately in many cases have low susceptibilities to tetraethyl lead. If this susceptibility could be stepped up to the point where these straight run stocks could qualify as blending agents for the production of aviation fuels, a great increase in aviation gasoline volume would result.

The author has demonstrated in laboratory and plant that if these stocks are freed of their deleterious sulfur content they may in fact be used as aviation base or blending stocks.

As is well known, there are five ways to remove sulfur (in whole or in part) from a gasoline, namely, multistage caustic wash, solutizer treatment, caustic-methanol extraction, hot clay treatments in various forms, and sulfuric acid treatment. Of these, however, the only ones that seem adapted for direct treatment of very sour straight-run gasolines are the hot clay treatment and the sulfuric acid treatment; the last named, while very effective, is also expensive, so the author leaves it out of present consideration. The following example is cited.

Desulfurization of West Texas Aviation Base Stock

	Undesulfurized	Desulfurized
Gravity, API	61.1	60.6
IBP	112	115
10%	166	168
50%	212	216
90%	266	269
EP	316	319
Recovery	98%	98%
Color	30	30
Sulfur	0.080%	0.015%
Octane number, CFR MM..	67.0	68.5
Plus 1 cc TEL	75.8	79.0
2 cc	79.6	83.4
3 cc	81.8	86.2
4½ cc	84.0	88.7
6 cc	85.1	90.1
ASTM gum	None	None
Copper dish gum	None	None
Induction period	8 hrs. +	8 hrs. +
Susceptibility (Hebl. et. al)	1.37	1.93

The hot clay treatment here referred to is a form of the process owned by the Gray Process Corp., in which the treatment is at 600° F. under a pressure of 20 lbs. per sq. in.

PHYSICS

The Effect of Polar Impurities Upon Capillary and Surface Phenomena in Petroleum Production—F. C. Benner and F. E. Bartell, before AMERICAN PETROLEUM INSTITUTE, 22nd Annual Meeting, San Francisco, November, 1941.

Very little data on the surface forces active at the interfaces of actual petroleum reservoirs exist. Data on surface forces obtained for interfaces of simplified systems of pure materials must be used with caution when applied to actual production problems, because of the marked depression of interfacial tensions often caused by adsorption of polar impurities present in the crude oils of actual systems. The normally hydrophilic rock material of petroleum reservoirs, usually silica or limestone, may be greatly altered in nature, or even caused to become hydrophobic, through adsorption of basic or acidic polar impurities from the crude oil. Chemisorption of basic polar compounds appears to take place at acidic silica surfaces, whereas acidic polar compounds are chemisorbed at basic limestone surfaces.

A preliminary study of the alteration of the hydrophilic rock material made by means of contact-angle determinations indicates that a thorough study of

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GEOPHYSICS

Volume VI, Number 4
October, 1941

A Direct Reading Phase Shift Meter — *Joseph D. Eisler*
The Relation Between Depth, Lithology, and Seismic Wave Velocity in Tertiary Sandstones and Shales — *N. A. Haskell*
Seismic Velocities in the Southeastern San Joaquin Valley of California — *E. J. Stulken*
The Probable Errors of Delta-T Velocities — *Frederick Romberg*
Comparison of Well Survey and Reflection "Time-Delta Time" Velocities — *W. E. Steele, Jr.*
Notes on Refraction Prospecting — *Charles Hewitt Dix*
Current Penetration in Direct Current Prospecting — *M. Muskat and H. H. Evinger*
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such alteration, using a series of oil-water systems which would give a wide range of measurable and reproducible interfacial contact angles, should throw much light on actual production problems.

Laboratory Study of Water Encroachments in Oil-filled Sand Columns—Frank G. Miller, in BUREAU OF MINES REPORT OF INVESTIGATIONS. No. 3595, October, 1941; 32 pages.

It is now generally understood that oil in a reservoir sand which is under hydrastatic pressure may be recovered by what is technically referred to as "water drive," in which the water, which lies below the oil, rises up into the sand and forces the oil to flow out through the oil well.

While the principle of water drive is now perfectly clear, there are many things about water drive that are not clear. In particular, there has been obtained no definite information regarding the proper rate at which the driving water should be allowed to penetrate into the oil sand. This question may be stated thus: What are the effects of different rates of edgewater encroachment on the ultimate recovery of oil from the reservoir? From what has heretofore been published about field and laboratory investigations on the subject, there has arisen a more or less hazy opinion that the slower the rate at which an oil field is produced, the greater will be the ultimate recovery. This seems to presume that faster rates will be more conducive to by-passing and trapping of oil that might otherwise escape.

In an effort to clarify the proposition the Bureau of Mines made an extensive investigation in its San Francisco laboratory. Tubes were filled with quartz sand resembling the unconsolidated sand usually found in oil bearing formations; this sand was saturated with oil and the oil was displaced by water drive at rates equivalent to 0.06 to 7 feet per day, which is about the range of the rates of edgewater movement observed in operating oil fields.

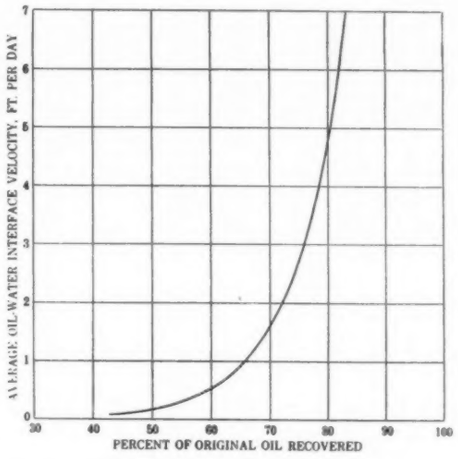


Figure 9 - Graphic representation of experimental results showing the trend of the relationship between the average oil-water interface velocity and the percentage of oil recovered

The author found that the percentage of original oil recovered tended to increase as the average velocity of the oil-water interface was increased. The experimental data showed a range of error such as might be expected in experiments of this sort, but the data are consistent enough to warrant drawing the ideal curve shown in the accompanying figure. The implication is clear that less oil is recovered at slow than at faster rates of edgewater encroachment.

This is contrary to what has been believed, and is somewhat disconcerting. The author is careful to point out that these data are laboratory data, and should not be applied to field practice without more extensive verification.

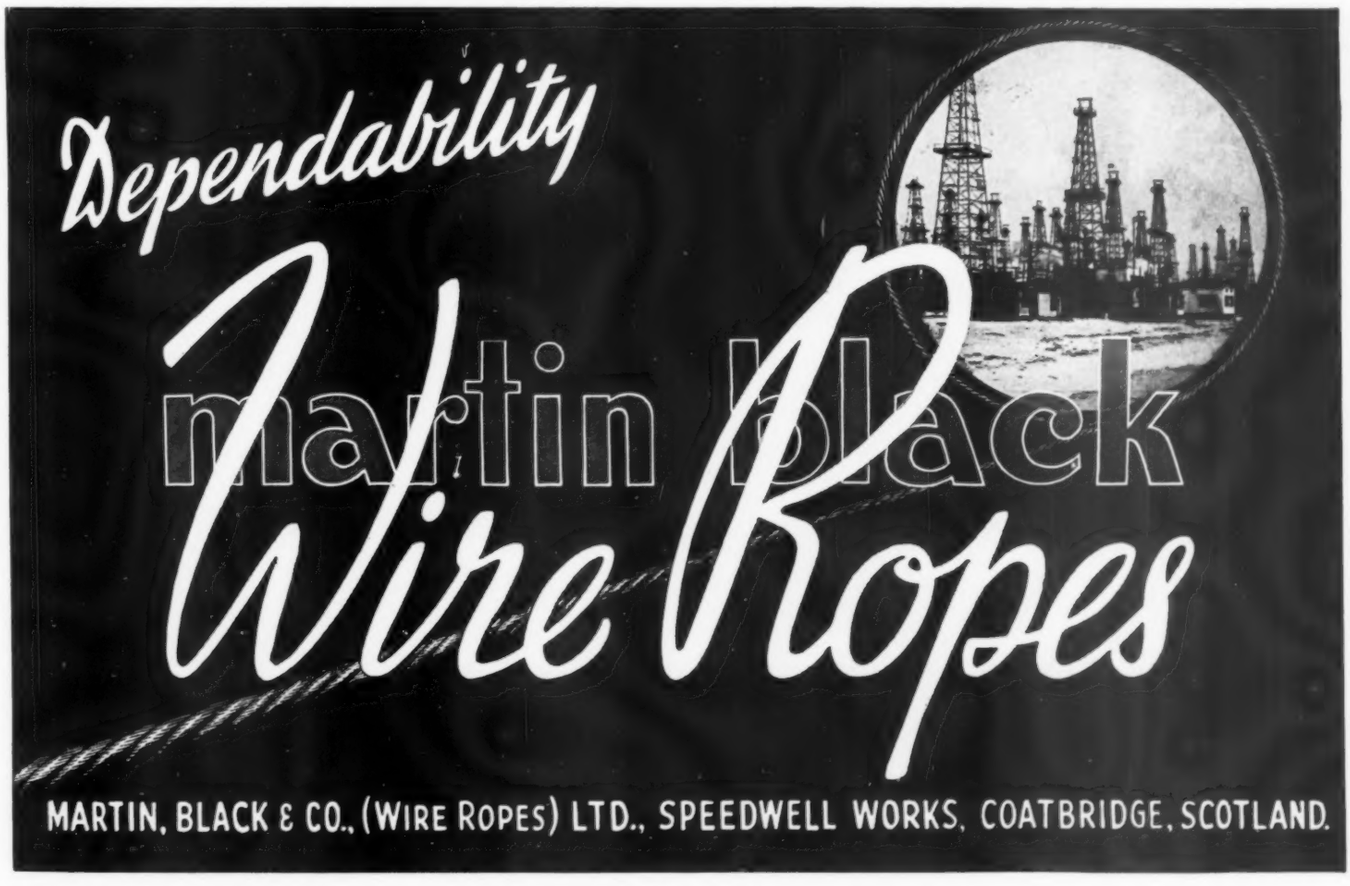
CHEMISTRY

Extreme Pressure Lubricants; Film-Forming Action of Lead Naphthenate and Free Sulphur—G. L. Simard, H. W. Russell and H. R. Nelson, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 33 (1940), No. 11, pp. 1352-1359.

Lead naphthenate plus free sulfur oils on metal surfaces tend to form lead sulfate under mild treatments (low temperatures, short heating periods, or low loads) and lead sulfide under more severe conditions. Surfaces of hypoid gears operated 20,000 miles exclusively in this lubricant consisted mainly of iron oxide and a phase believed to be a lead-rich form of lead sulfide.

Lead naphthenate oils produced an amorphous film on metals of either adsorbed lead naphthenate or of an oxidized product of lead naphthenate. Iron surfaces treated with free sulfur oils formed a superficial film of iron oxides.

The results are discussed in the light of recent theories of boundary lubrication.



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GENERAL

A Prospecting Program for the Dominion (of Canada)—Esme Eugene Rasaire, in CANADIAN OIL & GAS, Vol. 2 (1941), No. 3, pp. 6-14.

It is set forth that Canada's undiscovered reserves of petroleum are very probably of enormous magnitude, and that the time is at hand when increased efforts should be made to find and exploit them.

The author points out that Canada, as a possible oil country, is largely virgin territory where oil prospecting can take advantage of methods which have been painfully worked out in the United States, but without going through the same evolutionary stages of these methods. His program, concisely stated, is as follows:

In testing a given region there should first be collected all available geological information, which would be sifted for indications of favorable structures or conditions that suggest the more or less probable presence of petroleum accumulations. The next step would be a wide-mesh geochemical reconnaisance to define areas where the surface soil carries appreciable traces of hydrocarbons that are migrating upward from the depths. These areas are then "high-graded," to pick out those that appear to show the greatest promise. These selected areas, or the most promising one among them, is then prospected by the reflection seismograph in a careful search for structural traps, and/or evidence of stratigraphic wedges. If such appear, the next step is to sink an exploratory "slim" hole down to current drilling depths. This exploratory drilling would be carefully observed by making analysis of cuttings, looking for micropaleontological markers, and testing for petroleum hydrocarbon content, not omitting to log the hole electrically. The slim hole will not be designed with the ultimate object of getting petroleum out of it, but simply in order to obtain geological information and to locate oil formations, if any. If oil is found, the location is turned over to the production department; if no oil is found, a minimum of expense will have been incurred.

USES

Response of Aircraft Fuels to Tetraethyl Lead—A. G. Cattaneo and A. L. Stanly, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 33 (1941) No. 11, pp. 1370-1372.

The Ethyl blending chart for evaluating lead response of gasoline in the A.S.T.M.-C.F.R. engine has been extended into the region above 100 octane number. The extension is consistent with the original chart in that the line representing the response of a given fuel is continuous and of constant slope throughout its length.

The extended chart permits a quantitative measure of lead susceptibility throughout the range from 0 octane number to isooctane plus 3 cc. of tetraethyl lead per gallon.

This chart has been in use for several years and found reliable for lead concentrations up to 3 cc. per gallon. For higher concentrations of tetraethyl lead the chart is useful but is not so well established, partly owing to lack of sufficient data and partly to the large influence which small variations in the sulfur content may have, particularly in the region above 60 octane number. Below 3 cc. of tetraethyl lead the chart can be considered more reliable than any one individual octane number determination.

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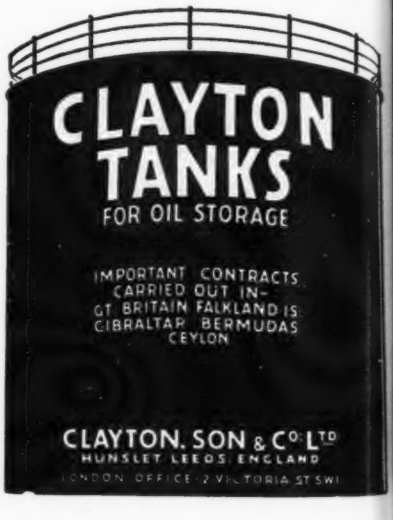
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